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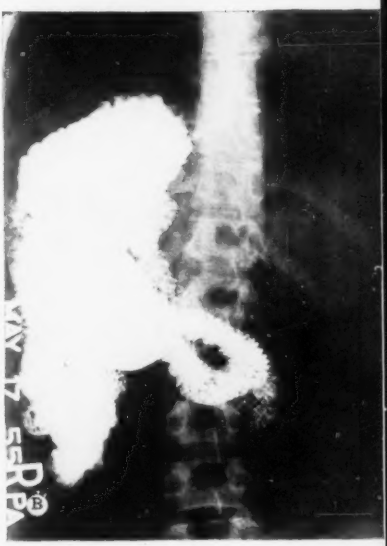

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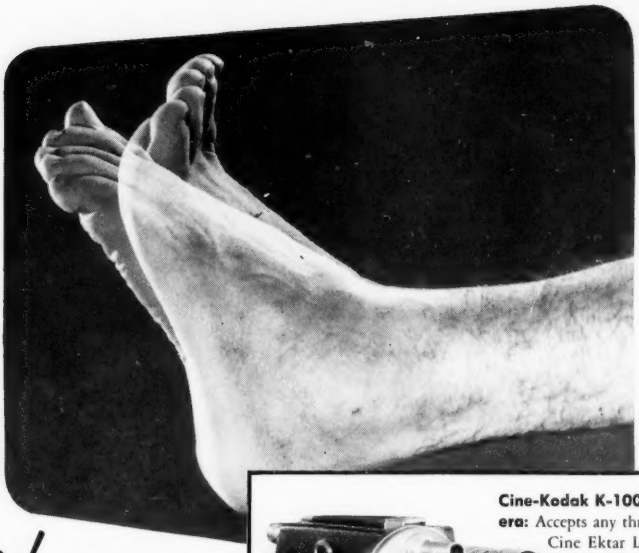

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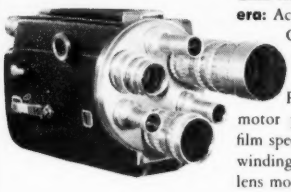

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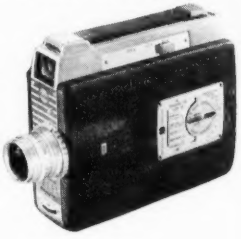

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Editorials

FROM THE RUSSIAN SURGICAL CLINICS

IN THIS issue of the A. M. A. ARCHIVES OF SURGERY will be found three papers written by Prof. P. I. Androsov, M.D., of the Sklifosovsky Institute, of Moscow, and Scientific Research Institute of Experimental Surgical Apparatus and Tools, U. S. S. R. Ministry of Public Health. They were sent to Major Paul Schafer (MC), U. S. Army, with the request that they be reviewed by the editorial board of one of the American surgical journals for publication, and Major Schafer, knowing of our desire to publish his and Dr. F. H. Ellis' observations made on recent trips to the Russian surgical clinics and hospitals, sent the papers to the editors of the A. M. A. ARCHIVES OF SURGERY. They have been reviewed and accepted for publication. The readers, we are sure, will find much of interest in the methods of anastomosing blood vessels by a mechanical apparatus, about which we have heard but which few of us have had an opportunity to see. The "machine" and its parts are well shown in the illustrations in the article. In sending the papers to us for consideration for publication, Major Schafer stated that they have been reviewed and passed on as suitable for publication by the appropriate government agencies.

Dr. Ellis' paper on his trip appeared in an earlier issue of the ARCHIVES, and in the not-too-distant future we hope to be able to publish Major Schafer's observations on his trip to Russian surgical centers.

WALTMAN WALTERS, M.D.

Professor Androsov's articles should be of considerable interest to American surgeons, representing as they do a new freedom in the exchange of ideas with the medical profession of the Soviet Union. In recent years no Russian surgeon has sought publication of original work in surgical journals of this country.

Early last fall I visited Professor Androsov in Moscow at the Sklifosovsky Institute, a hospital made famous by the late Professor Yudin. I was impressed by the work that he and his associates were doing in peripheral vascular surgery and in the reconstruction of lye burns of the esophagus. Professor Androsov was extremely hospitable and showed a keen interest in the freer exchange of knowledge between American and Soviet surgeons. He and his staff evinced a friendly interest in American medical institutions as a result of Professor Yudin's visit to the Mayo Clinic and other institutions in this country in former years.

Let us hope that other Soviet surgeons will follow Professor Androsov's lead in submitting to us from time to time reports of their work.

F. Henry Ellis Jr., M.D.

New Method of Surgical Treatment of Blood Vessel Lesions

P. I. ANDROSOV, M.D., Moscow

It was established during the Second World War that the operation to be preferred in field conditions is that of ligating vessels in the wound; vascular sutures were used in 0.8% of cases only.

Ligating large vessels may lead to necrosis of the extremity and, as a rule, always results in its reduced function because of inadequate blood supply. This had been stated long ago by A. P. Krynov:

"In a number of cases I had the occasion of ligating large arteries, such as the subclavian, iliac, femoral arteries, etc., and I should like to note that even if no necrosis of the extremity was observed after ligation, such patients subsequently exhibited all kinds of trophic disturbances on these extremities."

From the papers published during the Second World War, I have collected the following data regarding the occurrence of gangrene after ligation of the femoral and popliteal arteries: The ligation of the femoral and popliteal arteries results in gangrene in 8% to 30% of cases. Vascular sutures account for a smaller number of cases of gangrene than the ligation of vessels. In his work, B. L. Khenkin cites the following figures: Of the 396 operations made by the ligature method, 9.3% ended in amputation, while of the 224 operations made by the vascular suture method only 3.6% resulted in amputation.

B. V. Petrovsky recorded 6.1% of gangrene of extremities out of 393 cases of ligature of vessels. When trunk vessels were ligated (288 cases) the incidence of gangrene of extremities was as high as 11.5%. The same investigator had 3.09% of cases of gangrene of the extremities when performing 97 operations to restore the lumen of the vessels.

The infrequent application of vascular sutures in the surgical treatment of blood vessel lesions, in spite of its unquestionable advantage, can be explained by the difficulty of performing vascular sutures by the manual method, i. e., with a needle and thread (even possibly with an Atraumatic needle), as well as by frequent thrombosis at the site where they are applied.

Recorded for publication July 31, 1956.

Sklifosovsky Institute, Moscow, and Scientific Research Institute of Experimental Surgical Apparatus and Tools, U. S. S. R. Ministry of Public Health.

All the methods of connecting blood vessels by hand with the help of a needle and thread, apart from being complicated in the technical sense, have a number of common shortcomings, namely: (*a*) They are incapable of preventing thrombosis; (*b*) they do not safeguard against repeated bleeding; (*c*) they lead to the narrowing of the lumen of the vessel at the site of the suture; (*d*) they require too much time; (*e*) they do not afford the possibility of suturing vessels of small caliber.

For vascular sutures to become practically realizable, it is necessary to eliminate the above shortcomings in the existing methods of suturing vessels. This is attained by using a mechanical method which makes it possible to apply automatically faultless vascular sutures.

In 1945-1950, a group of Soviet engineers (V. F. Gudov, N. N. Kapitanov, L. I. Kukushkin, F. U. Poliakov, A. P. Kakabvan, and A. A. Strekopytov) and physicians (N. P. Petrova, M. G. Akhahia, and P. I. Androsov) developed a method of connecting blood vessels by mechanical means and constructed the required apparatus.

The apparatus so constructed (Fig. 1) is intended to apply a circular suture on vessels from 1.3 to 15 mm. in diameter, with due consideration for the various thickness of the walls. The suturing of blood vessels is done by means of inverted U-shaped clips with pointed ends. The clips are made of

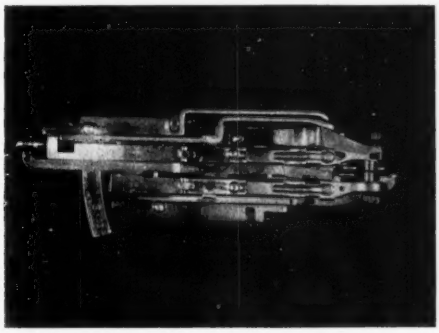

Fig. 1.—General view of the vessel-suturing apparatus. (All Figures: A. F. I. P. 1872.)

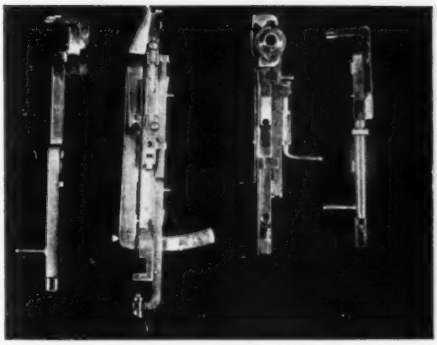

Fig. 2.—The vessel-suturing apparatus disassembled into four parts: (1) left hemostatic clamp; (2) clipping part of the apparatus; (3) supporting part of the apparatus; (4) right hemostatic clamp.

tantalum wire of a round section, from 100μ to 200μ in diameter, depending on the diameter of the vessel to be sutured and the thickness of the walls. The instrument consists of numerous parts, but it can be dissembled without any difficulty in a short space of time. The great advantage of the apparatus, which makes it within the reach of rank-and-file surgeons, is that one has to operate only four major parts of the apparatus: (1) left hemostatic clamp; (2) clipping part of the apparatus; (3) supporting part of the apparatus; (4) right hemostatic clamp (Fig. 2).

In order to perform the operation of suturing, the ends of the injured vessels, from 1.5 to 2 cm. long, are isolated from the surrounding tissue, following which the hemostatic clamps of the apparatus are applied to the isolated ends of the vessel. After the clamps have been applied, the vessel is fastened by the semibushings of the instrument. The ends of the vessel are turned inside out, with the intima outside on the bushing of the instrument as a cup (this is done with the help of two anatomical eye pincets) and is fastened in this position by the jaws of the cup clamp. After fastening the vessel on the bushings, the left and right parts of the instrument are joined and locked by a connecting plank. The intimas of the vessel ends closely adhere then to one another. The vessel is sutured

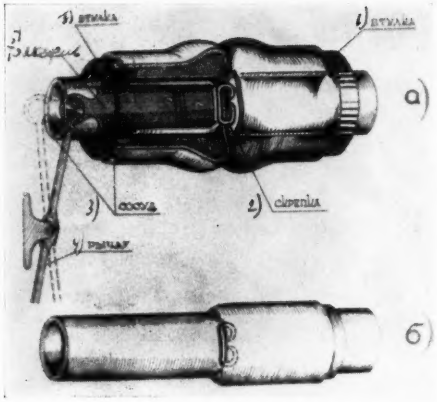

Fig. 3.—Diagram of a mechanical vascular suture (*a*) view of a sutured vessel turned inside out on the apparatus bushings; (*b*) view of a sutured vessel after the apparatus has been removed: (1) bushing, (2) clip running through the walls of both ends of the vessel, (3) vessel, (4) lever, (5) pusher, (6) bushing.

in several fractions of a second by pressing the lever. The latter drives the tantalum clips, located in the semibushings of the clipping part of the instrument, into the tissue of the folded ends of the vessel. On their way the clips run through both walls of the vessel and rest against the hole of the supporting part of the instrument. The legs of the clip, each getting into its respective hole, are bent to assume a B-shape, which ensures an air-tight and firm connection of the vessel ends (Fig. 3). (To illustrate better the position of the clip, a part of the cup in the sutured vessel has been cut out.)

When the apparatus has been removed from the sutured vessel, the latter assumes the appearance shown by the Figure.

A vessel-suturing one-clip apparatus was also constructed to apply longitudinal sutures on blood vessels.

The method of connecting blood vessels, and the apparatus, were first tried by us on animals. Between 1948 and 1952, mechanical vascular sutures were applied in 394 cases during experimental operations on dogs. The experiments made on the animals proved that mechanical vascular sutures guaranteed accurate connecting of the edges of the vessels so sutured, the uninjured intima of the pieces of the vessel being contiguous for a considerable length, without growing narrower on the site of the suture. The tantalum clip, remaining outside the vessel, does not hinder the blood stream, does not cause any thrombosis, and does not disturb the blood supply of the vessel walls.

Histological examination revealed that the ends of the vessel adhered well on the ninth day owing to the regenerating endothelium, by first intention, without any granulation being developed. The interior surface of the line of the suture becomes covered with a tender layer of endothelium; there is no rough proliferation of the intima or development of any cicatricial process. There are no giant cells in the tissues, around the tantalum clips, since the tantalum alloy appears to be "neutral" with respect of the tissues, and thus no inflammatory reaction is caused around the clips.

After the positive results in the experiments on animals had been obtained, we were in a position to apply the vessel-suturing apparatus at the Sklifosovsky Institute clinic in urgent cases of injured blood vessels, traumatic aneurysms, arterial thrombosis, transplantation of blood vessels, and in creating an additional blood supply of some organs.

This paper is intended to give an account of the results of surgical treatment of fresh blood vessel lesions and traumatic aneurysms.

It is known that in cases of injured blood vessels the operation which restores continuity of the vessel is considered as being the most perfect, since it is more physiological and rapidly restitutes the normal blood supply of the respective extremity or organ. This method has not, however, been widely applied to this day on a mass scale, even in clinics, because of the complexity of applying vascular sutures by hand and the subsequent unsatisfactory results.

The new method of applying sutures on blood vessels by means of tantalum clips

has made this intricate operation simple and available to rank-and-file surgeons, ensuring, as a rule, a favorable outcome of the operation. Whereas formerly the time of operating in cases of injured blood vessels was debatable, and some investigators put off the operation until the collaterals developed, the application of the vessel-suturing apparatus has made it possible to perform the operation as soon as the lesion of the vessel has been detected and the patient's condition permits surgical intervention.

The method of operating by means of the apparatus in the case of vessel lesions consists in the following: A tourniquet is applied above the site of lesion (if possible), which is followed by a primary treatment of the wound. The injured vessel is detected. If there is a mural lesion (less than a third of its circumference) or longitudinal lesion of the vessel, mural sutures may be applied by means of the one-clip apparatus, regardless of the length of the wound. If, however, the defect of the vessel wall precludes the application of a lateral suture, it is best to cut the vessel completely at the site of the lesion, isolate its ends from the surrounding tissue, refresh it, turn it inside out on the bushings of the apparatus, and apply a circular suture.

By using this method, we successfully performed 29 operations of suturing blood vessels (Table 1).

We sutured arteries of a small caliber when the lesion threatened to considerably derange the blood supply of the extremity. Thus, from three cases, we are in a position to state that operations made by means of applying a mechanical vascular suture on small-caliber vessels helped to save the upper extremities of the patients and ensured their subsequent good functioning.

By way of illustration here is a clinical case.

CASE 1.—Patient M., a woman aged 25, was admitted to the Sklifosovsky Institute on June 15, 1951, with a traumatic amputation of the right forearm. When admitted, the patient exhibited an almost complete traumatic amputation in the lower part of the right forearm; the distal part of the extremity was held only by a small dorsal strip of skin. The wrist was markedly cyanotic and cold and had signs of complete disturbance of blood supply (Fig. 4).

The operation was done 30 min. after the wrist had been injured. The crushed edges of the wrist were sparingly excised under conduction anesthesia, according to Kulenkampff's method. The injured branches of the ulnar and radial artery and vein were detected, and, after being refreshed, their ends were sutured by the end-to-end method by means of the vessel-suturing apparatus, the diameter of the bushing being 2 mm. After the vessels had been sutured, a clear pulsation appeared, and the wrist grew warm. The tint of the skin likewise changed: The wrist turned pink. The two ends of the radial bone were sutured with wire, and the dislocated ends of the ulnar

TABLE 1.—*Results in Twenty-Nine Cases*

Name of Injured Vessel	Total No. of Patients	Type of Suture		Results	
		Circular	Longitudinal	Recovered	Died
Common carotid artery	1	1	--	1	--
Brachial artery	6	6	--	6	--
Brachial vein	2	2	--	2	--
Radial artery	6	6	--	6	2
Radial vein	2	2	--	2	--
Ulnar artery	4	4	--	4	--
Ulnar vein	1	1	--	1	--
Femoral artery	6	5	1	6	--
Femoral vein	1	--	1	1	--
Total	29	27	2	29	--

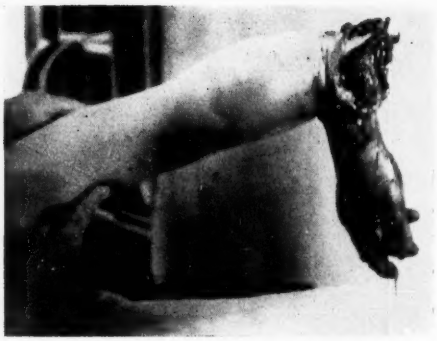

Fig. 4.—Patient M's wrist before operation.

Fig. 5.—Patient M's wrist two years and seven months after operation.

bone were set and fastened with stitches. All the tendons of the wrist flexors were sutured, as well as the ulnar and median nerves. The wound was washed with a penicillin solution and sutured. A gypsum bandage reaching to the middle third of the arm was placed on the extremity. The postoperative period was uneventful. Two months later the gypsum bandage was removed. The function of the wrist began to improve progressively, and two years and seven months later, when the patient was examined, it appeared that she was in good health and had no complaints. The function of the right wrist was fully restored (Fig. 5).

We still have too few cases of applying vascular sutures in fresh lesions of blood vessels. There is, however, ground for stating that the application of mechanical vascular sutures in cases of vessel lesions is quite possible and highly advisable.

Vascular Suture for Surgical Treatment of Traumatic Aneurysms

In surgical treatment of traumatic aneurysms, nearly all the numerous methods of operation are based on ligation of the vessels.

Thus, L. M. Ratner, in performing 350 operations for traumatic aneurysms, applied circular sutures only twice and lateral ones 36 times. S. P. Shilovtzev operated on 143 patients affected with traumatic aneurysms. Vascular sutures were used in nine cases only; of these the circular suture was applied once, and the lateral eight times. This can be explained by the imperfection of the vascular suture. The demand that the technique of applying vascular sutures should be improved was put forth as far back as 1910 by V. B. Gubbent, who wrote in his work "In Liberated Port Arthur": "There is no doubt that when the technique of applying vascular sutures is improved, the operative treatment of aneurysms will make another step forward, as this operation will help in completely restoring blood circulation in the wounded region."

My own observations deal with 42 cases of various traumatic aneurysms; in nearly all of them continuity of the vessels was restored by means of a mechanical vascular suture by the end-to-end method after the traumatic sac had been excised.

The method of operating on traumatic aneurysms with the application of a vascular suture by means of the apparatus is as follows: In the case of arterial aneurysm, a rubber tourniquet is placed, but not tightened, under the region to be operated on, above the site of the aneurysm (to provide for any bleeding which might set in from the aneurysmatic sac when it is isolated). A wide cut of the skin is made along the vascular bundle and above the aneurysmatic sac. It should be of sufficient length to allow the baring without any difficulty of the leading-in and derivative ends of the artery forming the aneurysmatic sac. The subcutaneous tissue, cicatricial tissue, and fascia are cautiously excised.

The numerous thin trunks are ligated carefully with a thin nonabsorbable surgical

(silk) suture, with pulsation as a guide (which is the positive aspect of operating without a tourniquet), and the arterial trunk is isolated from the vascular sheath.

A narrow gauze braid wetted in a saline solution is put under the vessel, above the aneurysm. The artery below the aneurysmatic sac is isolated in the same way, and a provisional gauze braid is similarly placed under it. By pulling the gauze braids, one can nearly stop for some time the flow of blood into the section of the aneurysmatic sac. After the ligatures have been made ready, the aneurysmatic sac can be isolated from the surrounding tissues at a faster pace. The isolation should be started from the vessels to the periphery, gradually coming nearer the pathological fistula.

As soon as the isolation of the aneurysmatic sac has been completed, a hemostatic clip of the clipping part of the vessel-suturing apparatus is placed on the prepared artery, above the sac. A hemostatic clip of the supporting part of the apparatus is applied to the artery, below the sac. The next step is to cut out the aneurysmatic sac together with the defect of the vessel which occupies half or more than half of its circumference.

Before being turned inside out, the ends of the intersected artery should be refreshed by cutting off as small a part as possible. Then they are turned inside out on the bushings of the apparatus in accordance with the diameter of the vessel. The clipping and supporting parts of the apparatus are connected, and the vessel is sutured by the end-to-end method. When the suture has been applied, the clipping and supporting parts of the apparatus are disconnected and released from the vessel. The vascular anastomosis is located between the hemostatic clamps of the apparatus.

The hemostatic clamps of the apparatus are removed first from the distal and then from the proximal section. If there is some slight bleeding from the line of the stitches after the removal of the clamps, it can be readily stopped by pressing against it a gauze wetted in a saline solution. If the bleeding is profuse, additional individual sutures should be applied with the one-clip vessel-suturing apparatus.

The operation is completed by applying sutures to the wound, layer by layer, after preliminarily washing it with a penicillin solution (from 5 to 6 cc. of a saline solution containing 300,000 to 500,000 I.U.). The extremity is attached to a splint for five or six days. On the expiration of this period, it is advisable that the patient should start making motions with the extremity operated on. On the ninth day the patient is allowed to walk.

In cases of arteriovenous aneurysm, temporary ligatures are placed under arteries and veins or held in position by screw hemostatic clamps designed by the Scientific Research Institute of Experimental Surgical Apparatus and Tools. In such cases the aneurysm is almost excluded from blood circulation. By thoroughly isolating the aneurysmatic sac from the surrounding tissues one reaches the pathological fistula. The hemostatic clamps of the apparatus are applied to the artery and vein at 1.5 to 2 cm. from the aneurysmatic sac; the clamps of the clipping part, to the central ends of the artery and the vein, and those of the supporting part, to their peripheral ends. The aneurysmatic sac is excised. The ends of the sectioned vessels are turned inside out on the bushings of the apparatus (Fig. 6). Then they are sutured by the end-to-end method (Fig. 7).

Operations according to the above methods have been successfully performed by us on patients affected with both arterial and arteriovenous aneurysms (Table 2).

The aneurysms mostly resulted from bullet wounds of the vessels, and only in three cases from cut wounds. The duration of the ailment was as follows: less than 5 years, 2 cases; from 6 to 10 years, 25 cases; over 10 years, 15 cases. As a result of the long duration of the disease, nearly all the patients exhibited cardiovascular disturbances, which were confirmed electro-

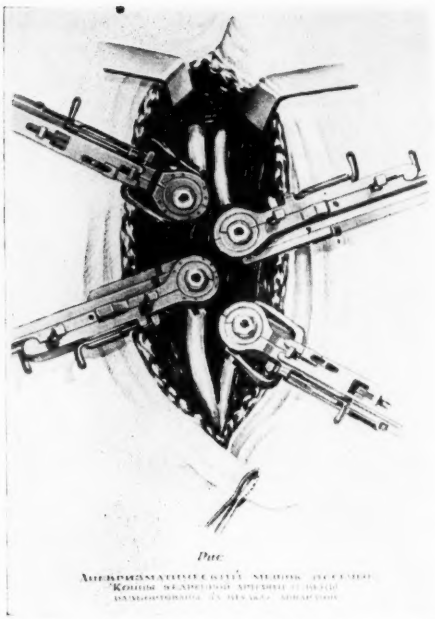

Fig. 6.—The aneurysmatic sac has been excised. The ends of the artery and the vein are turned inside out on the apparatus bushings.

Fig. 7.—Completed mechanical suture. Artery and vein have been are sutured.

cardiographically, roentgenologically, and oscillographically, as well as major trophic changes in the extremities. Our observations coincide with the experimental data collected by B. V. Ognev and the clinical observations made by S. P. Shilovtzev, L. M. Protalinsky, and others, on the influence of the size of the pathological anastomosis on the cardiovascular system in cases of arteriovenous aneurysms. The sooner the pathological vascular anastomosis is eliminated through operative intervention and continuity of the vessels is restored by a vascular suture, the sooner are conditions created for the improved heart function and the elimination of trophic disturbances.

In almost every case we used arteriography, which showed good continuity of

TABLE 2.—*Results in Forty-Two Cases of Aneurysm*

Name of Artery	Kind of Aneurysm		Total Cases	Kind of Suture				Results	
	Arterial	Arteriovenous		Circular		Longitudinal		Good	Satisfactory
				Artery	Vein	Artery	Vein		
Common carotid	1	2	3	3	3	--	--	3	--
Subclavian	1	3	4	1	--	3	2	2	2
Axillary	1	2	3	3	1	--	--	3	--
Brachial	1	1	2	2	1	--	--	2	--
External iliac	1	5	6	6	--	--	5	5	1
Femoral	2	18	20	19	7	1	3	18	2
Popliteal	1	3	4	3	2	1	1	4	--
Total	8	34	42	37	11	5	11	37	5

the vessel at the site of the mechanical suture. The following case may be cited as example.

Case 2.—Patient B., aged 32, was admitted to the Sklifosovsky Institute on Aug. 17, 1954, complaining of an arteriovenous aneurysm of the right thigh and a trophic ulcer of the leg. The femoral arteriovenous aneurysm appeared in 1944 after the patient had been wounded. Since then the patient had suffered from acute edema of the right thigh and leg and a large trophic ulcer of the leg, and he was troubled by pain when walking.

An operation was performed on Aug. 21, 1954. A cut, 15 cm. long, was made longitudinally along the femoral artery, above the aneurysm, with the use of spinal anesthesia (0.7 of a 1% procaine [Novacain] solution). The femoral artery and vein were isolated above and under the aneurysmatic sac, and provisional ligatures were placed under them. The aneurysmatic sac, 8×6 cm., located in the upper part of the femoral artery, was excised, following which a defect of the femoral artery and vein was formed, 3.5 cm. long. The ends of the femoral artery were mobilized, held in position by the hemostatic clamps of the apparatus, and turned inside out on the 4.8 mm. diameter bushings of the apparatus. Then they were sutured by the end-to-end method. The ends of the femoral vein were likewise turned inside out on the 5.7 mm. diameter bushings of the apparatus and sutured by the end-to-end method.

After the removal of the apparatus, good pulsation set in and a clear pulse appeared on the vessels of the foot. On the operating table a contrast substance, a 70% solution of Cardiotrast, was introduced into the femoral artery, above the anastomosis, and a roentgenogram of the vessel was made, which demonstrated good continuity of the vascular anastomosis (Fig. 8).

The wound was sutured. The postoperative period was uneventful. The wound healed by first intention. On the 10th day after the operation, the patient was able to walk, the trophic ulcer was healed, and the pulse in the vessels of foot was good. The patient was discharged in a satisfactory state with the extremity functioning adequately. At present his condition is good and he is engaged in physical work.

The end-to-end suturing of a vessel by means of the apparatus is possible only when the gap between the ends equals 3 to 3.5 cm. When the defect is greater, a plastic operation of the vessel is indicated by means of transplanting a small piece of a vein (autoplastic operation) or of a conserved artery (homoplastic operation). We carried out successfully the grafting of a vein into the defect of an artery in 9 cases and the grafting of a conserved artery in 12 cases.

Fig. 8.—Arteriogram of the right femoral artery after it has been sutured in Patient B. Continuity of the artery at the site of the suture and the clip at the site of suturing are well apparent.

We therefore came to the conviction that the apparatus is helpful in solving the problem of vascular sutures both in cases of urgent surgical operations and in cases of surgical intervention in vessels; the vessel-suturing apparatus helps in attaining the utmost speed of suturing vessels and of securing reliable stitches. The technique of mechanical suturing precludes any possibility of the suturing material getting into the lumen of the vessel and thus safeguards the patient against thrombosis at the site of the anastomosis.

Conclusions

In cases of wounds of blood vessels the operation with the application of mechanical sutures should be performed when the wound in the vessel has been detected and

the patient's condition permits surgical intervention.

The operation of suturing injured blood vessels by the apparatus is simple and within the reach of rank-and-file surgeons, and, as a rule, produces favorable results.

If it is impossible to connect the vessel by the end-to-end method because of its large defect, transplantation of a small piece of a vein into the defect of the artery is indicated; this operation, performed by means of the vessel-suturing apparatus, deserves to be widely applied in surgical practice.

Operations in Cases of Aneurysms

Restoration of Continuity of Arteries by Means of Grafts Without Isolating the Aneurysmatic Sac

P. I. ANDROSOV, M.D., Moscow

Ligation of vessels in surgical treatment of aneurysms was applied in 97.5% of cases during World War II.

Operations in cases of aneurysms with ligation of large vessels often result in necrosis of the extremity or in its reduced function, which is accounted for by insufficient blood supply.

Between 1950 and 1955 we operated on 43 patients with various aneurysms of the trunk vessels, and in every case the continuity of the vessels was restored by means of a mechanical vascular suture applied by the vessel-suturing apparatus.

When operating for aneurysms, one is bound to encounter great technical difficulties caused by considerable adhesions between the aneurysmatic sac and the surrounding tissues. Sometimes the aneurysmatic sac and vessels are calcified in the region of the pathological anastomosis, and for this reason the operation of restoring the continuity of the vessels becomes impossible. The anatomical position of the aneurysm may likewise impede the operation.

The above considerations led us to the idea that it was possible to restore the continuity of vessels by means of a graft without isolating the aneurysmatic sac.

Experimentally, we used an autotransplant of a vein in repair of the defect of an artery 15 times and a conserved artery homotransplant 12 times. If the graft was of the same diameter as the artery, microscopic examination did not reveal any formation of aneurysm-like dilation of the vein (even in cases of transplantation into the abdominal aorta). Only a thickening of its wall was recorded.

A longitudinal cut of the artery wall showed that the latter passed into the vein wall without any pronounced boundary. Sometimes the difference is so slight that it is difficult to distinguish the vein from the artery and to find the site of the vascular suture. In appearance and thickness the vein is similar to the artery. Its internal surface is lined with a smooth and shiny intima.

Histological examination of the graft showed a considerable reconstruction of the vein wall, chiefly of the tunica media, which is conditioned by the new functions and greater load. Owing to the development of collagen and smooth muscle fiber, the formation of a wide network of vasa vasorum, and the subsequent appearance of elastic fibers, the vein wall greatly resembles the structure of the artery wall.

No pronounced degenerative changes in the graft were recorded. Neither did we observe any substantial degenerative changes in the homotransplants of conserved arteries, even in experiments involving a prolonged period of observation (427 days). Satisfactory functional and morphological results were obtained in every case. The ingrowing of the graft proceeded without any thrombosis, divergence of sutures, or bleeding. It should be stressed that this subject is still under investigation, and the conclusions cannot be considered as final.

The positive results of experimental observations enabled us to introduce the experience of transplanting vessels into the clinic. Grafting the autotransplant of a vein into the defect of an artery was effected by us in 7 cases; the homotransplant of a conserved artery was applied to 11 patients.

The method of the operation we suggest is the following: In cases of arterial aneu-

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Sklifosovsky Institute, Moscow, and Scientific Research Institute of Experimental Surgical Apparatus and Tools, U.S.S.R. Ministry of Public Health.

rysm a cut is made along the vascular bundle above the aneurysmatic sac; it should be so long as to make it possible to bare without any difficulty the leading-in and derivative ends of the vessels forming the aneurysmatic sac. The artery is isolated proximally from the vascular sheath, and from the sac to the periphery. It is held in position by elastic hemostatic changes, then ligated at two points on the site where it passes into the aneurysmatic sac, and then dissected between the clamps and the ligature. A section is taken from the autotransplant of the vein, of approximately the same diameter as the artery, and this is transplanted into the artery defect so formed; in this case the central end of the artery should be sutured to the distal end of the vein. Such a disposition helps to prevent the appearance of any impedance to the blood stream on the part of the venous valves.

When transplanting a conserved artery (Fig. 1), the conventional method of applying a vascular suture is used. The technique of transplantation is considerably simplified if the vessel-suturing apparatus is used.

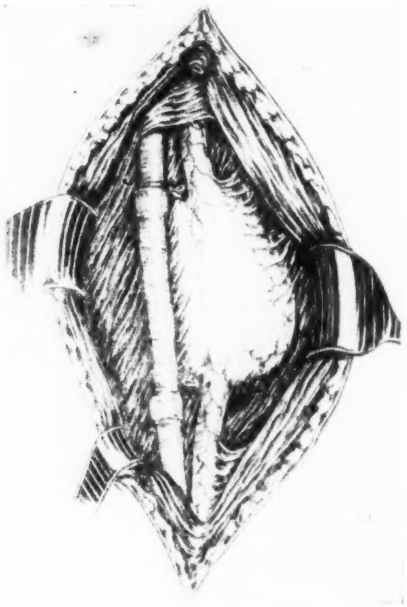


Fig. 1.—Diagram showing a completed operation of restoring continuity of an artery by means of an autotransplant or conserved artery in cases of arterial aneurysm, with the sac excluded.

If the excluded aneurysmatic sac is large, it can be dissected, the clots removed, and the bleeding vessels (which are encountered very seldom) ligated, and the sac is then sutured with interrupted crimped sutures. We successfully applied this method in six patients affected with arterial aneurysms; in two of them the artery defect was replaced by a vein autotransplant (the brachial artery in one case and the femoral artery in another case), and in four patients, by a conserved homotransplant from an artery (common carotid artery in one patient, axillary in one, iliac artery in one, and femoral in one).

Report of Cases

Case 1.—Patient M., aged 28, was admitted to the Sklifosovsky Institute on Feb. 2, 1954, with arterial aneurysm of the right brachial artery, which developed after a shell-fragment wound received in 1944. The patient complained of a pathological mass in the upper third of the right shoulder, a feeling of numbness of the right arm, and reduced sensitivity and acute muscular weakness as compared with the left arm (diameter of the right wrist was 15 cm., and that of the left, 48 cm.).

Pulse was rhythmic, 72 per minute, drastically weakened in the right radial artery. The boundaries of the heart were not dilated; the tones were clear. The belly was soft; the liver and spleen were not palpated.

The cicatrices from the through shell-fragment wound and a pathological mass along the vascular bundle, 6×8 cm., were felt in the upper third, on the medial surface, of the right shoulder. A rough systolic murmur could be heard above the mass, which extended distally and proximally for a considerable distance. The systolic murmur was not heard when the right brachial artery was pressed above the mass. The pulse of the right radial artery was greatly weakened. Oscillography revealed the following: oscillometric index of the right shoulder, —8 mm.; of the left shoulder, —7 mm.; of the right forearm, —0.52 mm., and of the left forearm, —4 mm.

Conclusion: the curve of the left shoulder is of a proper shape, with an average arterial pressure of 85 to 90 mm.; the average arterial pres-

sure in the right shoulder amounts to 45 to 50 mm. The pulsation of the vessels in the right forearm is weakened. All these findings point to a weakening of the blood supply in the right upper extremity below the aneurysm.

Neuropathologist's conclusion: paretic phenomena in the right ulnar nerve (of an ischemic nature).

Roentgenogram revealed calcification in the aneurysmatic sac.

After necessary preparations an operation was performed on Feb. 23, 1954 (P. I. Androsov). A longitudinal incision (15 cm.) was made, with use of local anesthesia with a 0.5% procaine (Novocain) solution, on the medial surface of the right shoulder along the vascular bundle, layer by layer, up to the aneurysmatic sac. The leading-in and derivative ends of the artery were isolated. The aneurysmatic sac was committed firmly to the surrounding tissues, nerve trunks, and brachial vein.

The isolated ends of the brachial artery were held in position by the hemostatic clamps of the vessel-suturing apparatus, and the ends were ligated where they passed into the aneurysmatic sac. The artery was sectioned at two points between the clamps and the ligature. The defect so formed in the artery, 5 cm. long, was replaced by a graft taken at random from a right cubital subcutaneous vein.

The vein graft was sutured to the ends of the brachial artery by means of the vessel-suturing apparatus; the upper end was sutured with a bushing of 2.9 mm., and the lower end, with a 2.5 mm. bushing. The aneurysmatic sac was dissected, revealing fresh and old blood clots. The bleeding vessels of the sac were sutured from the side of the sac lumen, and the sac was sutured with crimped sutures. Good pulsation of the brachial artery and the graft became apparent. A vasogram of the graft was made on the operating table after the injection of a 10% solution of Cardiotrast. It revealed good continuity (Fig. 2).

The wound was washed with a penicillin solution and sutured layer by layer.

The postoperative course was uneventful. From the very first day of the operation the pulse of the right radial artery was well filled. The patient was discharged on March 20, 1954, i. e., 25 days after the operation.

Case 2.—Patient O., aged 27, was admitted to the Sklifosovsky Institute on Jan. 12, 1955. He was brought from the Velikie Luki Regional Hospital in a grave condition with an enormous aneurysm in the right iliac region. The aneurysm developed after a bullet wound received during the Great Patriotic War in 1944. Since 1952 the patient had begun to feel edema in the right leg, pain when walking, and an increased abdominal

Fig. 2.—Vasogram of the right bronchial artery at the site of Patient M.'s vein graft. Good continuity is apparent throughout the brachial artery.

mass in the right iliac region at the site of the former wound. Since 1954 the patient had not been able to walk because of pains and edema in the leg, which made him apply for stationary treatment at a hospital.

In the last five months, while he was in hospital, his temperature rose in the evenings to 39 C (102.2 F). The mass in the right iliac region swelled up, and the pains became incessant, decreasing only with the application of anaesthetic drugs. In view of the increasingly aggravated state of health and unsuccessful treatment, the patient was transferred to the Sklifosovsky Institute. When examined at the Institute, the patient proved to be highly emaciated; the skin was pallid, with a reduced turgor; the patient could not sit up because of weakness. The pulse was rhythmic, 104, and filled satisfactorily. The tones of the heart were dull, with a systolic murmur at the apex; the abdomen was soft, and no pains were felt. An abnormal mass could be felt in the right inguinal region, which occupied the whole of the right iliac region and the upper third of the thigh. The mass extended deeply into the pelvis minor and almost completely occupied it. The intumescence pulsated, and a systolic murmur could be heard above it. The right extremity was flexed at the knee joint at 90 degrees, with a stable

contracture. The muscles of the thigh and shin were acutely atrophic. The pulse was not felt on the vessels of the right foot. Blood pressure was 100/60, and the hemoglobin content was 30%. No oscillographic curve was apparent on the right foot. Diagnosis pointed to a traumatic arterial aneurysm of the right iliac artery attended by a considerable cardiovascular derangement. It was decided to bring the patient out of the grave state before the operation by transfusing blood and plasma, by improved diet, and by the application of large doses of antibiotics. The general state of the patient continued, however, to deteriorate. The intumescence in the right iliac region began to swell markedly. The skin above the intumescence became tense. The temperature of the body was 38 to 39 C (100.4 to 102.2 F); leukocytosis, 16,800, with a considerable shift to the left. Because of acute pains in the extremities, the patient could not sleep at all. In view of the danger of necrosis of the skin above the aneurysmatic sac from strain, and of its subsequent rupture, as well as of suppuration in the aneurysmatic bag, it was decided to operate on the patient. (Figure 3 shows the patient before operation.)

Fig. 3.—Photograph of Patient O. before the operation.

The operation was performed on Feb. 10, 1955. (operation performed by P. I. Androsov). A cut was made above the inguinal ligament and downwards to the upper third of the thigh along the vascular bundle above the aneurysmatic sac. This was done under spinal anesthesia effected by means of 0.5 of a 1% dibucaine (Sovcaine) solution between L-1 and L-2, the patient lying on his right side, with a local infiltration anesthesia of a 0.5% procaine solution added. The external iliac artery above the sac was isolated from the surrounding tissues as well as the femoral artery below the sac; both were held in position by the hemostatic clamps of the vessel-suturing apparatus. Following this, the iliac and femoral arteries were ligated at the point where they pass into the aneurysmatic sac and sectioned between the clamps and the ligature. The defect so formed in the iliac and femoral arteries, 8 cm. long, was replaced by a graft of a conserved femoral artery of a corpse belonging to the same group, the time of conservation in the blood of the same corpse being two days, and the temperature, 4 C. The suturing of the graft was done by means of the vessel-suturing apparatus, a bushing 4.9 mm. in diameter being used. After the hemostatic clamps had been removed, there appeared a clear pulsation of the graft and the femoral artery. The aneurysmatic sac was dissected, and 2 kg. of gray blood clots were removed from its lumen. The sac was partly sutured with crimped stitches and drained with a thin rubber drain. The wound was washed with a penicillin solution and sutured layer by layer. A vasogram of the graft and the iliac artery was made after the introduction of 10.0 mg. of a 50% Cardiotrast solution, which showed that continuity was restored.

The postoperative period was uneventful. From the first few days the temperature of the body dropped to normal, the pains in the leg disappeared, and the patient began to recover rapidly. Thirty-eight days after the operation, the right extremity in the knee joint began to extend almost completely and the patient was able to walk. A repeated vasogram of the right iliac and femoral arteries was made on the 65th day after the operation, which demonstrated that they were well permeable, including the graft (Fig. 4).

In cases of arteriovenous aneurysm the method of operating remains nearly the same. The artery is isolated only above and below the aneurysmatic sac. The isolated artery is held in position by hemostatic elastic clamps and ligated at two points at the aneurysmatic sac. The artery is sectioned between the hemostatic clamps and the ligature. A section of the autovein or of a conserved artery is transplanted into the defect of the artery by means of the vessel-suturing apparatus (Fig. 6).

With the application of this method in the operation for arteriovenous aneurysm,

Fig. 4.—Vasogram of Patient O. 65 days after the operation.

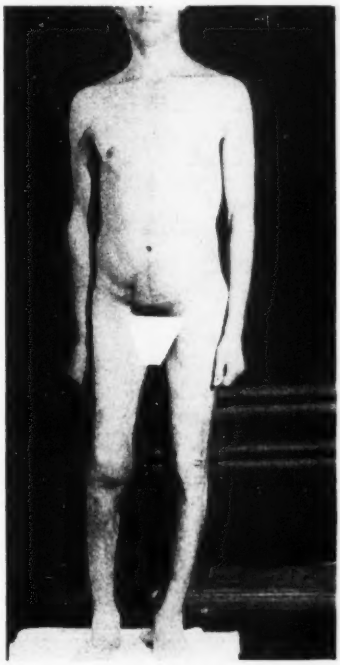
the aneurysmatic sac is not dissected; it remains connected with the veins, and this prevents the continuity of the vein from being disturbed.

We successfully used this method in three patients suffering from arteriovenous aneurysms (in one case aneurysm of the subclavian artery, and in two cases aneurysm of the femoral artery) when the defect of the artery was replaced by a conserved homotransplant of an artery. Some observations are cited below.

Case 1.—Patient S., aged 47, was admitted to the Sklifosovsky Institute on Sept. 10, 1953, having a left subclavian arteriovenous aneurysm. Had been wounded by a bullet in October, 1941, in the left side of the thorax. Since then the patient became an invalid of the second category. When admitted to the Institute, the patient complained of acute edema of the whole of the left arm, of limited movements in the elbow joint and wrist, and of constant pain. The latter intensified when the arm was lowered, which compelled the patient to sleep with the extremity lifted high up. The general state was satisfactory. Respiration was vesicular, with occasional moist crepitation. Heart boundaries: 1 cm. to the right from the right edge of the sternum, 1.5 cm. to the left and outwards from the midclavicular line. The tones were dull but rhythmic. Arterial pressure was 105/70 mm.; electrocardiogram indicated a myocardial lesion based on coronary changes. No pathological changes were revealed in the other organs. An abnormal mass was found in the left subclavian region. During palpation a marked pulsation and murmur were felt. Above the abnormal mass a rough murmur of a "top" was heard, which muffled the tones of the heart. The murmur extended to the whole of the cardiac region and gradually became weaker at the apex. Strong edema and acute cyanosis of the whole upper left extremity were observed, particularly pronounced in the wrist. The movements in the elbow joint and the wrist were considerably limited. In the region of the elbow joint there was an extensive trophic ulcer with a necrotic bottom and a suppurative secretion. No pulsation of the left brachial or radial artery was felt.

The shape of the curves and the oscillometric index for the right arm did not deviate considerably from normal. The curve for the left arm and forearm was greatly extended, which was attended with a very high oscillometric index, exceeding

Fig. 5.—Photograph of the patient 60 days after the operation.



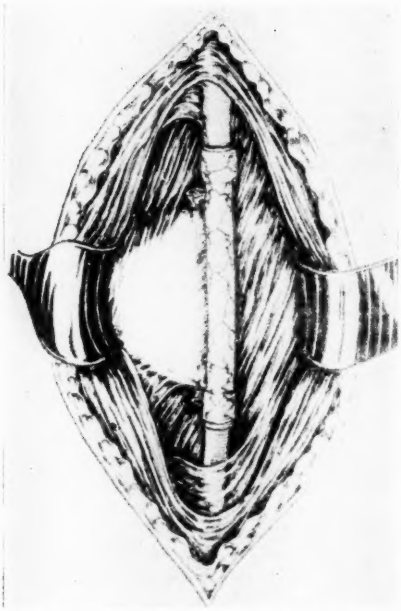


Fig. 6.—Diagram showing a completed operation of restoring continuity of an artery by means of a graft in cases of aneurysm.

the capacity of the apparatus. This pointed to a marked dilation of the veins of the extremity and to a higher pressure under which arterial blood flowed to the veins.

The components of the urine and blood did not particularly deviate from normal. Diagnosis

	Left	Right
Circumference of the arm	50	26
Circumference of the forearm	38	18
Oscillometric index		
The shoulder is higher	45 mm.	10 mm.
The forearm	18 mm.	8 mm.

pointed to a left subclavian arteriovenous aneurysm with a considerable derangement of the blood supply of the extremity. The patient insisted that the extremity should be amputed. The diagnosis of the nature of operative intervention was discussed at a conference of the Institute physicians, where it was recommended that the extremity should be amputated, because of considerable trophic changes within it, and that an attempt should be made to plasticize the vessels before the amputation.

After the necessary preparation, an operation was performed on Sept. 29, 1953 (P. I. Androsov). The arteriovenous aneurysm of the subclavian artery was bared by an arc-shaped cut under the left clavicle, with sectioning of the sternal edge of the clavicle. For local anesthesia a 0.5% procaine solution was applied. The aneurysmatic sac proved to be included in the fibrous tissue, with the brachial plexus spread and embedded on it. The proximal and distal ends of the vessels were isolated and attached to holders. Hemostatic clamps of the vessel-suturing apparatus were applied to the subclavian artery more proximally and distally than the aneurysmatic sac, and the artery was sectioned directly at the sac. The artery was sectioned between the ligatures and the clamps. A 4 cm. defect was formed in the subclavian artery, into which a conserved graft of a femoral artery was sutured by means of the vessel-suturing apparatus. The graft had been kept for 12 hours in the blood of a cadaver. The central end of the artery was sutured with a 4.9 mm. bushing, and the peripheral end, with a 4.1 mm. bushing.

Continuity of the anastomosis was good, and the pulsation was apparent to the eye. Thus continuity of the subclavian vessels was restored without the aneurysmatic sac being isolated or removed. The pulse of the left radial artery was not felt.

In the postoperative period the edema rapidly became reduced, the skin got wrinkled, and the tension of the tissues disappeared. The pains ceased, and there were full movements in all the joints. The tint of the skin became normal. The trophic ulcer healed. On Oct. 28, 1953, nearly a month after the operation, the patient was discharged with a well-functioning upper extremity. The circumference of the left upper extremity almost corresponded at the time of discharge to the size of the right one (arm, 28 cm.; forearm, 18 cm.).

On Oct. 19, 1954, a letter was received from the patient in which he wrote that his "left arm, like the right one, is quite sound."

The above case provides us with convincing proof that it is quite possible and highly advisable to restore the continuity of vessels by means of a graft in cases of aneurysms, without isolating the aneurysmatic sac.

With such methods the operation for aneurysm is not very traumatic; it is not attended with any loss of blood or lesion of the collaterals in the circumference of the sac, and it requires little time.

There is reason to believe that such operations may become widely used in the surgical treatment of aneurysms.

Blood Supply of Mobilized Intestine Used for an Artificial Esophagus

P. I. ANDROSOV, M.D., Moscow

The methods of creating an artificial esophagus are numerous, but most of them have been given up as imperfect. The creation of an esophagus out of a small intestine transferred into the subcutaneous tunnel of the thoracic wall according to Roux-Herzen-Yudin's method is considered as the best method in esophagoplastic operations in cases of serious burns; in cases of medium and slight burns S. S. Yudin's transpleural method is given preference.

Between 1928 and 1955, plastic operations for an artificial esophagus were performed in the Sklifosovsky Institute on 696 patients; only in 6 of them was the skin used, and in 2, the large intestines; in all the other cases the small intestine was used.

These impressive figures prove the unquestionable advantage of creating an artificial esophagus wholly out of the small intestine.

In uneventful total small intestine esophagoplastic operations it is possible to create within two weeks a new well-functioning artificial esophagus. What is mainly required for the successful completion of the plastic operation is a sufficient mobilization of the small intestine, which makes it possible to bring it to the proper level.

Most failures of such esophagoplastic operations result from the fact that it is not possible to mobilize a section of the small intestine of sufficient length. This is often related to the unfavorable structure of the vascular network of the small intestine mesentery.

The absence of well-pronounced vascular arcades which would permit the cutting of several radial vessels of the mesentery excludes the possibility of cutting the mesentery of the intestine at a great length and mobilizing a sufficiently long section of the intestine. This may result in an insufficient blood supply of the mobilized intestine which has already been brought out into the subcutaneous tunnel and may lead to partial or total necrosis of the intestine. In such cases the patient has to be operated on repeatedly: The necrotic section of the intestine should be removed, and the esophagoplastic operation should be completed by means of a skin tube, which considerably delays the completion of the esophagoplasty. However, even if such a combined plastic operation proceeds without any complications, the patient has to undergo a number of other operations.

At the Sklifosovsky Institute, where the technique of small intestine esophagoplastic operation has been sufficiently developed, it is possible to mobilize a section of the small intestine of sufficient length only in 75% of cases. In the remaining 25% of cases failure resulted from the unfavorable disposition of vessels in the mesentery of the mobilized small intestine section.

According to the summary data collected by N. A. Bogoraz (1930), an artificial esophagus was made of the small intestine in 35 patients. Direct connection of the mobilized intestine with the esophagus in the neck was made 10 times—of these, only 6 times successfully.

It is therefore comprehensible that the search for the possibilities of mobilization

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of a small intestine segment of required length, regardless of the degree of development of the mesenteric vascular network, is a problem of prime importance.

Since 1928 S. S. Yudin has carried out important research work at the Sklifosovsky Institute to master the technique of various kinds of esophagoplasty. The Roux-Herzen method, which hitherto had not been widely applied, was accepted as the basis. A profound theoretical substantiation of the operation was provided by the many-year's work (over 300 operations for artificial esophagus, personally performed) and a detailed study of the blood supply of the small intestines. S. S. Yudin suggested a method of mobilizing the small intestine by separate ligation of the blood vessels and nonligated dissection of the mesentery, which made it possible to mobilize the intestine to the necessary level in 75% of cases; thereby the Roux-Herzen operation, instead of being unique, became within the reach of every surgeon.

In 1949, B. A. Petrov and G. R. Khundadze suggested that the hilus of the whole small intestine mesentery should be displaced, which makes it possible to pull up the mobilized section of the intestine still higher without disturbing blood circulation in it. This method cannot, however, guarantee the bringing out of the mobilized intestine high enough in every case. Still, it helps in many cases to overcome the difficulties encountered. The mobilization of the mesentery hilus does not preclude the danger of necrotization of the intestine resulting from its insufficient blood supply, though this method by itself does not impede the blood supply and cannot lead to intestinal necrosis.

In 1952, A. A. Shalimov suggested a method of preliminary ligation of the vessels of the intestine to be mobilized, as a way of training it to withstand conditions of insufficient blood supply. This method was deficient in that it was necessary to divide the operation into two stages and that adhesions were formed, which greatly hindered the mobilization of the intestine during the second laparotomy.

In 1926, V. N. Shamov reported to the Eighteenth Congress of Russian Surgeons on a new principle of esophagoplastic operations, of using a small intestine wrapped in the skin of rolled pedicle graft. This method raised for the first time the major problem of additional blood supply to the intestine through the collaterals, which developed in the subcutaneous fat tissue of Filatov's strip, and even of transferring the whole of the mobilized intestine to subcutaneous blood supply. The investigator did not, however, succeed in creating an artificial esophagus by this method, and its failure can be accounted for by the chief shortcoming of the method, its multistage character.

It might have appeared that all the opportunities had been used to perfect esophagoplastic operations and that hardly any substantial improvement could be expected in this field. This was not, however, the case. The problem of esophagus surgery cannot be considered solved, and further efforts are required to perfect the method of producing an artificial esophagus. Such new methods of operation did, as a matter of fact, appear very soon. This was helped by the development of a method for and means of mechanically suturing blood vessels.

The problem of vascular sutures was solved in 1950, when an apparatus was constructed which applies vascular sutures and simplifies the technique of this complicated operation.

This apparatus, which completely mechanizes the principal stages of the operation, was constructed in Moscow by a group of engineers (V. P. Gudov, N. N. Kapitanov, L. I. Kukushkin, F. U. Polyakov, A. P. Kakabyan, and A. S. Strekopytov) and physicians (N. P. Petrova and M. G. Akhalaya), with myself participating.

The whole set of the apparatus consists of three instruments designed to apply a circular vascular suture to vessels ranging from 1.3 to 15 mm. in diameter, with due

consideration for the different thicknesses of their walls. The apparatus is illustrated in the first paper of this series.

The suturing of the blood vessels is done by means of inverted U-shaped clips with pointed ends. The clips are made of tantalum wire of round section, from 100μ to 200μ in diameter, depending on the diameter of the vessel to be sutured and the thickness of its wall.

The technique of mechanical vessel suturing is such that any possibility of the suturing material getting into the lumen of the vessel is excluded. This prevents thrombosis on the site of the anastomosis (Fig. 1).

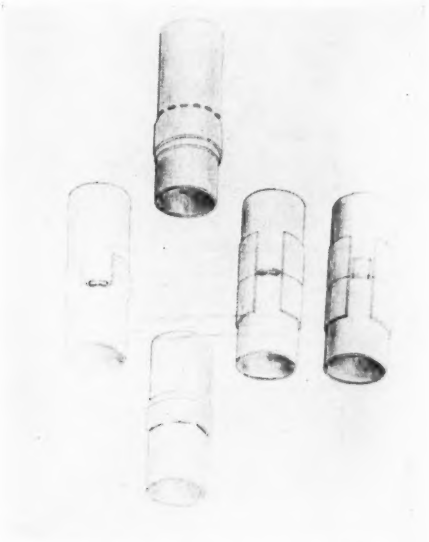

Fig. 1.—Vessel after being sutured.

Experimental and clinical investigations carried out on animals and patients (396 and 195 anastomoses, respectively) demonstrated that the vessel-suturing apparatus made it possible to attain maximum speed in applying vascular sutures and guaranteed sufficient solidity of the sutures.

The solution of the problem of mechanically suturing vessels has made it possible to master a new powerful method in plastic surgery, namely, provision of an additional blood supply for some organ or other, for example, a mobilized small intestine.

We set before ourselves the task of making an operation of applying vascular anastomosis in cases of esophagoplasty between the mesenteric artery of the small intestine and the arteries located at the site where the intestine passes on the anterior thoracic wall.

In development of the method and technique, vascular anastomosis between the left internal mammary and the second radial vessel of the mobilized mesentery proved to be the most feasible. It consists in the following procedure:

The abdominal cavity is opened by a superior median cut; the initial loop of the jejunum intestine is extracted, and the vascular network of the mesentery is examined. The intestine is mobilized at a distance of 5 or 6 cm. from the duodenojejunal ligament by dissecting the mesentery along the marginal vessel from which the straight vascular branches lead off to the intestine wall. The first radial vessel leading to the marginal vessel is released from the surrounding tissues of the mesentery, is cut off separately (artery, vein), not nearer than 0.5 cm. from the marginal vessel (to avoid thrombosis), and is ligated. The second radial vessel, which owing to its disposition is most convenient for vasculer anastomosis, is not cut off for the time being. The third and fourth radial vessels are isolated and ligated in the same way.

Thus the intestine proves to be sufficiently mobilized to be led up to the middle of the neck after the second radial vessel is cut off.

Two intestinal clamps are applied to the intestine, after it has been mobilized, in its initial section; the intestine is intersected between these clamps. The peripheral end is sutured with a twisted absorbable surgical (gut) suture, and the stump is subsequently sutured with a purse-string nonabsorbable surgical (silk) suture.

The oral end of the intestine is still held in position by the intestinal clamp, and subsequently it is to be used to apply a Y-shaped anastomosis. Instead of forming a tunnel under the skin of the thoracic wall, we extend the laparotomy cut of the skin to the anterior surface of the thorax along the left parasternal line to the neck. The edges of the skin are separated on both sides, for a distance of 5 to 6 cm., to form a convenient bed for the mobilized intestine. The cartilages of the second and third ribs to the left are resected, and the left internal mammary artery is isolated at a distance of 2.5 to 3 cm. A hemostatic clamp of

the clipping part of the vessel-suturing apparatus is applied to the isolated artery from the side of the subclavian artery. The internal mammary artery is cut off at a distance of 1.5 to 2 cm. from the branch of the clamp, and its peripheral end is ligated. Following this, the second radial arterial vessel of the small intestine mesentery is isolated at a distance of 3 cm. The hemostatic clamp of the supporting part of the apparatus is applied to the isolated artery from the direction of the marginal vessel, and the artery is so ligated that the end of the vessel is sufficiently long to make an anastomosis (1.5 cm.). The second end of the vessel leading to the hilus of the mesentery is ligated.

The mobilized and prepared intestine is raised upwards in front of the transverse colon and placed on the thorax into the previously formed bed.

The second radial vessel of the mesentery, held in position by the hemostatic clamp, is brought up to the clamp placed on the internal mammary artery. The ends of the vessels are turned inside out on the bushings of the vessel-suturing apparatus and are sutured by the end-to-end method. (Fig. 2).

The intestine is attached by separate stitches in its bed to the tissues of the anterior thoracic wall and to the avascular areas of the mesentery so as to avoid bends and tension in the region of the vascular anastomosis.

Fig. 2.—Diagram showing operation of vascular anastomosis between the left internal mammary artery and the second radial vessel of the mobilized intestine mesentery (the ends of the vessel are turned inside out).

After a vascular anastomosis has been applied in the conventional way, a Y-shaped anastomosis is applied between the afferent and efferent ends of the intestine. The abdominal cavity and the skin above the intestine are sutured. Five or six days after the first stage of the operation, its second stage may be started—the connecting of the intestine with the cervical section of the esophagus.

On developing and mastering the technique of the operation on a corpse, we thought it possible to apply it in the clinic, believing that it would favorably tell on improving the blood supply of the mobilized intestine.

It is in this way that we applied a vascular anastomosis between the internal mammary artery and the mesenteric vessel of the mobilized intestine in 11 cases of antethoracic esophagoplasty, using the small intestine.

In eight cases the total intestinal plastic operations with the use of vascular anastomosis were made in two stages (with cicatrical obstruction of the esophagus).

The following case is cited as an example.

Patient B, aged 30 years, was admitted to the Institute on March 24, 1950, complaining of a cicatricial contraction of the esophagus. In 1949, he suffered from a caustic soda burn of the esophagus, which resulted in the cicatricial contraction of the esophagus. Dilatation was performed repeatedly in 1949, but it was of no avail. Since July 1, 1949, he had received food through a gastrostomic fistula only. X-ray examination of the esophagus was carried out at the Sklifosovsky Institute on March 28, 1950, which showed that the liquid contrast medium passed freely along the esophagus only to the level of the upper edge of the fifth cervical vertebra. After preparation, the above-mentioned antethoracic plastic operation for an artificial esophagus was done on April 16, 1950 (performed by P. I. Androsov).

The abdominal cavity was opened by a superior median cut along the old cicatrix under spinal dibucaine (Sovcaine) anesthesia. The initial loop of the jejunum was extracted, and it appeared that the distribution of mesenteric vessels was highly unfavorable; there were well-developed radial branches, but their connecting arcades were rather poorly pronounced. For this reason, after the four radial vessels of the mesentery had been intercepted, and the mobilized intestine could be brought up to the neck,

the end of the intestine, 20 cm. long, assumed a cyanotic tint, which pointed to the apparent insufficiency of blood supply. After local anesthesia with a 0.5% procaine (Novocain) solution had been added, the cut of the anterior wall skin of the thorax was extended upwards along the parasternal line to the neck. The edges of the skin cut were separated on both sides for a distance of 4 to 5 cm. for the subsequent formation of an intestinal bed. A resection of the cartilages of the second and third ribs to the left was made at the sternum. The left internal mammary artery was isolated at a distance of 1.5 to 2 cm. and intersected after the application of the vessel-suturing apparatus clamps.

The second radial mesenteric vessel of the mobilized intestine was isolated in a similar way. A vascular anastomosis was applied by means of the apparatus by the end-to-end method between the central section of the left internal mammary artery and the second radial mesenteric vessel. Pulsation at the site of the anastomosis and the marginal vessel of the upper end became distinct. After the vascular anastomosis was made, the intestine assumed a normal tint. It was placed into the subcutaneous tunnel. A Y-shaped anastomosis was made between the afferent and efferent ends at the base of the mobilized intestine. The operation ended in suturing the wound, layer by layer. A rubber drain was inserted into the upper section of the skin tunnel through a separate small cut in the skin. The operation lasted 1 hour and 45 minutes.

In the postoperative period the patient's condition remained satisfactory from the very first day. The intestine peristaltized well. A week later, on April 21, 1950, when the patient was able to walk, the second stage of the artificial esophagoplasty was undertaken, namely, anastomosis of the cervical section of the esophagus with the lateral wall of the intestine that had been brought out. The second operation was performed under local anesthesia. On May 2, 1950, the sutures were removed, a small fistula being formed on the neck, with a saliva secretion. Two weeks after the second operation the patient was allowed to take liquid food per os. At the end of the third week the patient was able to take diverse food per os.

On May 23, 1950, a control x-ray examination was made of the patient's artificial esophagus, revealing that the contrast medium passed throughout the esophagus without any hindrance.

The gastrostomic tube which the patient had brought with him to the Institute was removed, and the fistula on the neck healed.

On June 3, 1950, the patient was discharged in good condition. At present he is in good health and is able to eat diverse food.

In three cases the total intestinal phastic operation with vascular anastomosis was completed in one stage (patients with esophagus removed because of cancer). Here is a case by way of illustration.

Patient S., a woman aged 35 years, was admitted to the Institute on Aug. 2, 1951, complaining of cancer of the esophagus attended with phenomena of difficult swallowing. X-ray examination of the esophagus made on Aug. 8, 1951, revealed an infiltration of the middle third of the esophagus walls, at a distance of 4 to 5 cm., with a drastic narrowing of its lumen. No changes were discovered in the stomach or in the duodenum.

On Aug. 20, 1951, the patient was operated on after necessary preparation. A transthoracic extirpation, from the right side, of the esophagus together with the tumor was made, and at the same time gastrotomy was done. Spinal anesthesia was used, followed by local anesthesia. The operation was performed by P. I. Androsov. The postoperative period was uneventful.

Two months later, on Oct. 29, 1951, an antethoracic esophagoplasty was done (operation performed by P. I. Androsov). The abdominal cavity was opened and the initial section of the small intestine was mobilized under spinal anesthesia; three radial vessels were intercepted. Contrary to the accepted rules, no Y-shaped anastomosis was made. The mobilized intestine was intercepted at its superior initial section. Both ends of the intercepted intestine were held in position by intestinal clamps. By this time a darkening of the upper section of the mobilized intestine occurred, and the pulsation of its vessel ceased, which pointed to insufficient blood supply of this section. Consequently, a vascular anastomosis was made between the second radial vessel of the intestine and the left internal mammary artery (I omit the description of the method of applying the anastomosis, as it has been given above). As soon as the vascular clamps were removed, the upper end of the intestine turned pink to a marked degree, and pulsation in the region of the anastomosis and in the terminal vessels reappeared. The mobilized intestine was placed in an open subcutaneous tunnel and attached with three stitches to the subcutaneous tissue of the anterior thoracic wall. An end-to-end anastomosis was made in the neck between the ends of the esophagus and the intestine. The lower section of the mobilized intestine was cut off and anastomosed to the stomach (end-to-side). The efferent end of the intestine was anastomosed end-to-end with the afferent end (coming from the Treitz ligament), which was placed on the clamp. This restored the continuity of the small intestines. The skin above the intestine and the abdominal

cavity were sutured. The diagram of the operation is shown in Figure 3.

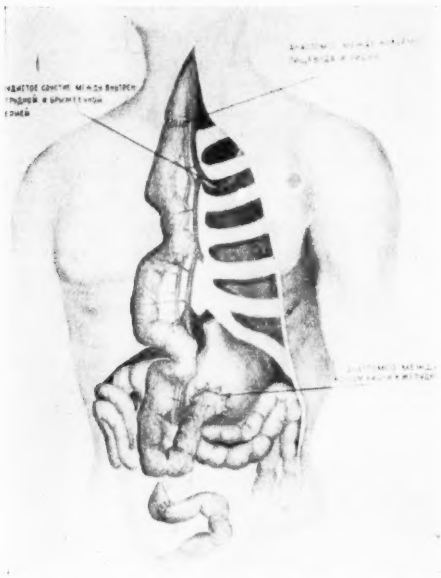

Fig. 3.—Diagram showing one-stage operation for an artificial esophagus with one-stage inclusion of the stomach and application of a vascular anastomosis between the vessel of the mesentery and the left internal mammary artery of Patient S. *1*, Vascular anastomosis between the internal mammary and mesenteric arteries; *2*, anastomosis between the ends of the esophagus and the intestine; *3*, anastomosis between the end of the intestine and the stomach.

The patient bore the operation well. On the 10th day she began to take liquid food through the artificial esophagus, and a week later she ate most diverse food. The gastrostomic fistula closed by itself. The patient was discharged in a satisfactory condition, with the artificial esophagus functioning well (Figs. 4 and 5).

At present the patient feels well, takes diverse food, and copes well with her duties of a teacher.

Not a single patient died. We experienced a failure once, when thrombosis of an anastomosis was formed as a result of acute vessel sclerosis which ended in necrosis of the upper end of the intestine.

On the basis of the experience thus accumulated we are in a position to state that the application of a vascular anastomosis between the internal mammary artery and the mesenteric vessel of the mobilized intestine is undoubtedly a very rational method in those cases when it is necessary to furnish additional blood supply to the intestine.

The idea of vascular anastomosis between the internal mammary artery and the mesenteric vessel is not new. As far back as 1921 Kramarenko and Mantseva attempted to perform this operation on a corpse, but they had no opportunity of performing it in clinical conditions.

In 1947, Longmire (Baltimore) made an anastomosis between the mesenteric vessel and the left internal mammary artery into a patient suffering from cicatricial obstruction of the esophagus. This is the only case so far made known in publications. As a matter of fact, with the manual method of suturing vessels such an operation could not be widely applied.

Anastomosis between the mesenteric vessel and the left internal mammary artery is technically quite realizable with the help of the vessel-suturing apparatus and is very convenient in practical surgical work. The left internal mammary artery lies on the path where the mobilized intestine is to be passed, and the isolation of the artery presents no particular technical difficulty in the process of suturing. Performing this operation by means of the apparatus will open up wide prospects of plastic surgery for an artificial esophagus.

Additional blood supply of the mobilized intestine can be effected in another way than by making an anastomosis between the internal mammary artery and one of the radial vessels of the intestine mesentery. There appears a supplementary source of blood supply in the superior-initial section of the intestine when the internal mammary artery is connected to one of the initial (generally the second) radial vessels. Blood supply of the intestine can, however, be increased from yet another source, namely, by supplying blood to the lower, distal section of the intestine. For this purpose it appears to be very convenient and effective to connect one of the radial vessels of the mobilized intestine mesentery to the right gastric-epiploic artery.

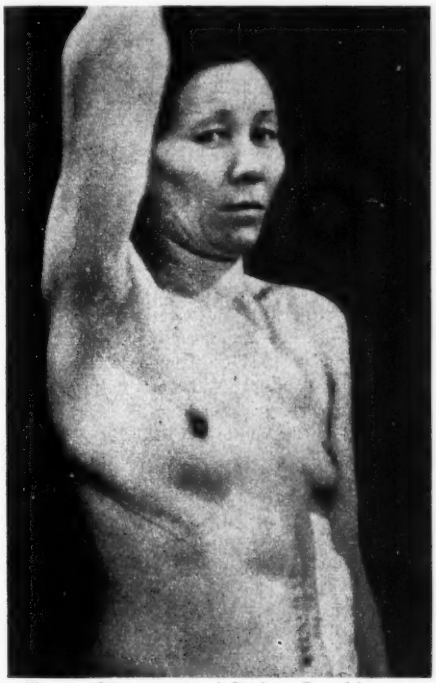

Fig. 4.—Photograph of Patient S., with a completed esophagoplastic operation following the extirpation of the esophagus for carcinoma.

The anatomical relationships between the lower section of the mobilized small intestine and the right gastroepiploic artery in the abdominal cavity are such that it is easy to apply a vascular anastomosis without any risk of bending it or of its excessive tension. Intersection of the right gastroepiploic artery does not affect the blood supply of the stomach or of the epiploon. We made a large number of experimental operations on corpses and became convinced of its feasibility.

We wish to suggest this new method of vascular anastomosis for cases of esophagoplastic operations in which the blood supply of the upper section of the mobilized intestine proves to be insufficient and when for various reasons it is not possible to anastomose the mesenteric vessel to the internal mammary artery. Most frequently this is impossible in intrathoracic and repeated reconstructive esophagoplastic operations. In the latter cases it is sometimes impossible, after necrosis of a part of the intestine, to isolate out of a multitude of adhesions the vessel required for connection with the internal mammary artery (basic marginal vessel). It is altogether impossible to use for this purpose one of the radial vessels, since there are not any; after the first operation there remains nothing more than their stumps, which are too short for anastomosis. On the other hand, it is almost impossible to make an anastomosis of the internal mammary artery with one of the newly isolated and intercepted radial vessels when carrying out an additional mobilization of the intestine. This is due to the fact that the vessels are at too great a distance from the artery.

At the same time, the right gastroepiploic artery is located near the last intercepted radial vessel of the mobilized mesentery.

Fig. 5.—Roentgenogram of the completed artificial esophagus of Patient S.

This permits easy connection of it with one of these vessels.

The new vascular anastomosis proves to be adjacent to the basic (last) radial vessel, which has not been intercepted during the mobilization of the intestine and which is instrumental in supplying blood to the whole of the intestine.

The vascular anastomosis supplies blood to the lower section of the mobilized intestine and reinforces from below the basic vascular trunk. This helps to restore normal blood supply in all the sections of the mobilized intestines. The technique of the operation is as follows.

A cut is made in the skin of the anterior thoracic wall above the remaining intestine after its necrosis during the first stage of the plastic operations. The intestine is isolated from the tissues of the thorax to which it adheres, using the sharp and obtuse method; care should be taken to avoid injuring the marginal vessel of the intestine. As soon as the intestine is isolated from the surface of the thorax, the abdominal cavity is opened, and the isolation of the intestine from the plane adhesions continues up to the hilus of the mesentery. The Y-shaped anastomosis is detected and is removed. The opening thus formed on the lateral side of the intestine is sutured with a two-layered stitch. The afferent end of the intestine which participated in forming the Y-shaped anastomosis is for the time being held in position by an intestinal clamp. The length of the remaining mobilized intestine is fixed, and the possibility is ascertained of increasing it by mobilization through cutting off the radial mesenteric vessels. To this end the mobilized intestine, isolated from the adhesions, is brought out of the abdominal cavity, and its mobilization is increased by intercepting the mesentery.

The peritoneum is cut from both sides of the mesentery above the radial vessels; the vessels are isolated from the fat tissue and then gripped by the hemostatic clamps not nearer than 0.5 cm. from the marginal vessel (to prevent its subsequent thrombosis), intercepted, and ligated. The extent of mobilization depends on the length of the intestine remaining after necrosis. As a rule, one has to intercept one or two radial vessels, which suffices for the direct connection between the end of the intestine and the cervical section of the esophagus. If there is doubt as to the sufficient blood supply of the mobilized intestinal loop (no pulsation of the marginal vessel and cyanotic tint of the intestine), a vascular anastomosis is applied between the right gastroepiploic artery and the last intersected radial mesenteric vessel of the mobilized intestine. The right gastroepiploic artery is easily detected at the edge of the large curvature of the stomach. The artery is isolated at a distance of 2 cm. and is intersected after a hemostatic clamp from the clipping part of the vessel-suturing apparatus has been placed, from the side of the duodenum. The end leading to the left gastroepiploic artery is ligated. The end of the right gastroepiploic artery, held in position in the hemostatic clamp of the apparatus, is turned inside out on a bushing 1.5 to 2 mm. in diameter. The end of the last intercepted radial mesenteric vessel of the mobilized intestine is isolated in the same way, fastened in the supporting part of the apparatus, and turned inside out on a bushing 1.5 to 2 mm. in diameter; following this, the right gastroepiploic artery is sutured to the radial mesenteric vessel by the end-to-end method (Fig. 6).

Fig. 6.—Diagram showing operation of vascular anastomosis between the mesenteric artery of the mobilized intestine and the right gastroepiploic artery (the ends of the vessels are turned inside out).

The afferent end of the intestine is anastomosed in a Y-shaped manner with the base of the mobilized intestine. The intestine is placed in a skin tunnel of the anterior surface of the thorax and neck previously prepared in the open or closed way. The skin over the intestine is sutured. The abdominal cavity is closed, layer by layer.

We applied anastomoses in this way at the clinic between the mesenteric vessel and the right gastroepiploic artery in 10 cases of reconstructive esophagoplastic operations, using the small intestine when the blood supply of the mobilized intestine proved insufficient.

Owing to the application of anastomoses, we succeeded in restoring the normal blood supply of the intestine in every case and to prevent its repeated necrosis.

Patient K., aged 19 years, was admitted to the Institute on May 15, 1950, complaining of a cicatricial stenosis of the esophagus and the larynx. On Oct. 2, 1949, the patient suffered from a burn caused by caustic soda, which was followed by a complete obstruction of the esophagus. On May 2, 1949, gastrostomy was performed at another hospital, and on June 24 tracheotomy was done because of difficulty in respiration (caused by the burn of the larynx).

On Dec. 19, 1949, the first stage of plastic operation for an artificial esophagus was made antethoracically at the same hospital, using the small intestine, which was extended to the neck. However, because of poor blood supply of the intestine, the latter became completely necrotic.

On June 17, 1950, a reconstructive operation for the creation of an artificial esophagus out of the small intestine was performed at the Sklifosovsky Institute; the intestine was brought up to the neck. However, its end became necrotic.

On June 10, 1950, a pharyngeal stoma was isolated, but it soon contracted. On Sept. 23, it was formed again.

On Dec. 6, 1950, a reconstructive antethoracic plastic operation was performed for an artificial esophagus.

The abdominal cavity was opened by a superior median cut along the old operation cicatrix under peridural anesthesia of a 1% tetracaine (Dicaine) solution with local procaine anesthesia added. The incision was extended to the thoracic wall, up to the pharyngeal stoma. The remainder of the mobilized intestine (which was kept from former operations) was isolated from the extensive adhesions of the abdominal cavity and tissues of the anterior thoracic wall. The end of the formerly mobilized intestine proved to be obliterated. It was resected (about 5 or 6 cm.). A radial (marginal) vessel of the mesentery was ligated, after which the intestine became longer by 15 to 20 cm. in order to improve the blood supply of the intestine, which after the ligation of the mesenteric vessel became somewhat cyanotic, a vascular anastomosis was made between the mesenteric vessel and the right gastroepiploic artery by means of the vessel-suturing apparatus. After the application of the anastomosis, pulsation of the gastroepiploic artery and the radial vessel became clearly apparent in that region. The intestine assumed a normal tint and exhibited good peristalsis. The Y-shaped anastomosis was resected and again made, 20 cm. below the previous one. Following this, the intestine was placed into a previously prepared bed on the thoracic wall, brought to the pharyngeal stoma, which had been enlarged, and connected in a one-stage procedure to the intestine by an end-to-end anastomosis. The abdominal cavity was closed, and the skin of the thoracic wall was sutured.

The postoperative period was uneventful. On the fourth day the patient was able to swallow liquid food. On the ninth day he took diverse food through the artificial esophagus. On the 10th day after the operation, he was discharged, with the artificial esophagus functioning well. At present the patient is also in good health and takes diverse food.

In all the cases the plastic operation for an artificial esophagus involving its completion by means of skin extensions would have required a good deal of time and much patience on the part of both the physician and the patient. The additional mobilization of the small intestines has made it possible to perform the plastic operation by using wholly the small intestine, which has greatly reduced the time of creating an artificial esophagus.

The additional mobilization of the small intestine is made possible by making a vascular anastomosis between one of its mesenteric vessels and the right gastroepiploic artery. No complications were recorded during the application of the vascular anastomosis.

Hence, the use of vascular anastomosis in operations for an artificial esophagus in patients suffering from a cicatricial stenosis of the esophagus, as well as after a resection of the esophagus in cases of cancer, has enabled us to restore in every case the normal blood supply of the intestine and to prevent its necrosis.

There is reason to believe that one of the most difficult problems of plastic surgery, additional blood supply of the intestine, when creating an artificial esophagus, has been solved to a considerable extent.

By using additional blood supply for the mobilized intestine resulting from anastomosis of the mesenteric vessel with the left internal mammary artery or with the right gastroepiploic artery, it has become possible not only to create an artificial esophagus out of the small intestine in many patients with a cicatricial narrowing of the esophagus but to considerably reduce the death rate as well.

In conclusion, I should like to cite yet another application of vascular anastomosis in intestinal esophagoplastic operations. In this case, additional blood supply of the mobilized intestine was effected by connecting its artery with the middle colic artery (arteria colica media).

Patient K., aged 23, was admitted to the Sklifosovsky Institute on Sept. 6, 1953, complaining of cicatricial obstruction of the esophagus on the level of D-3, which developed after a burn caused by caustic soda in June, 1951. Since September, 1951, the patient had been fed through a gastrostoma. Dilatation was attempted, but this was unsuccessful.

A year before, on Aug. 13, 1952, an attempt was made in Novosibirsk to create an artificial esophagus in the patient. The mobilized intestine became completely necrotic.

On Sept. 18, 1953, a repeated antethoracic esophagoplastic operation was performed (by Academician S. S. Yudin and Prof. P. I. Androsov).

A superior median laparotomy was made along the old cicatrix, with use of spinal anesthesia. A small section of the previously mobilized intestine was isolated from the numerous adhesions, and an additional mobilization of the small intestine was made. This necessitated the intersection of a large radial mesenteric artery.

This was immediately followed by acute insufficiency of blood supply of the mobilized intestine, and there was danger of its becoming necrotized, which would mean yet another failure. The intestine could be saved only through the creation of artificial additional blood supply. It was not possible to connect the mesenteric artery with the left internal mammary artery because the vessels were at too great a distance, and it was impossible to make an anastomosis with the right gastroepiploic artery because of the considerable difference in the diameter of these vessels.

An examination of the vessels of the stomach and of the large intestines revealed that the middle colon artery (arteria colica media) corresponded in its caliber to the intersected mesenteric artery of the intestine, was located very near it, and could be anastomosed to it (the middle colon artery is 7 to 8 cm. long). An experimental compression of this artery was not accompanied by any disturbance of blood supply in the transverse colon (which indicated the presence of developed collaterals). As a result, the artery was intersected. Its peripheral end was ligated, and the central end was mechanically sutured to the radial artery of the mobilized intestine (the apparatus bushing was 2 mm. in diameter).

The mobilized intestine assumed a normal tint; peristalsis began; soon a distinct pulsation of its peripheral vessels appeared.

The intestine was saved. The esophagoplastic operation was successfully completed by leading out the mobilized intestine. Recovery was uneventful.

The operation described above had not been developed in detail or tried in preliminary experiments on corpses; it was occasioned by accident in the process of every-day surgical practice and was suggested by life itself.

This is the only operation so far performed, and, since it has not been sufficiently analysed, I am unable to dwell on it in detail.

It should, however, be noted that the problem as a whole transcends the limits of esophagoplastic operations and additional blood supply of the intestine; it develops into a new vast problem of artificial blood supply of organs of the human body and of their unlimited grafting.

A Comparative Evaluation of Intravenous Pyelographic Media

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In an attempt to evaluate the newer intravenous pyelographic media introduced in this country, a comparative study of four different media was carried out in the Urologic Clinic of Henry Ford Hospital, Detroit.

The media used were sodium acetrizoate (Urokon sodium) 50% and 70%, sodium diprotrizoate (Miokon sodium*) 50%, diatrizoate (Hypaque†) sodium 50%, and a combination of the sodium and methylglucamine salts of ditrizoate (Renografin‡) 76%. Sodium acetrizoate is the sodium salt of 3-acetamido-2,4,6-triiodobenzoate, with a molecular weight of 578.9 and an iodine content of 65.8%. Concentrations of 50% w/v and 70% w/v were used. Sodium diprotrizoate is the sodium salt of 3,5-dipropionylamino-2,4,6-triiodobenzoic acid, with a molecular weight of 663.98 and an iodine content of 57.3%. A 50% w/v concentration was used. Diatrizoate sodium is the sodium salt of 3,5-diacetamido-2,4,6-triiodobenzoate, with a molecular weight of 636 and an iodine content of 59.87%. A 50% w/v concentration was used. Renografin is the sodium and methylglucamine salts of 3,5-diacetamido,2,4,6-triiodobenzoate, with a molecular weight of 613.8 and an iodine content of 62.1%. A 76% w/v concentration was used. Renografin and diatrizoate are different salts of the same base, whereas acetrizoate and diprotrizoate are salts of different bases. However, these compounds are all similar in respect to their organic chemical structure and all exhibit a low degree of toxicity, according to the data submitted by their manufacturers.

To eliminate any prejudice on the part of the investigator, the series was accomplished in four separate parts, each consisting of 200 cases. Each part involved the use of two different media, and, in each case, the investigator was given an unmarked syringe containing 20 to 25 cc. of an intravenous pyelographic medium. Exact confidential records were kept by the nursing staff, which were revealed to the investigator at the end of each part of the experiment. These records contained the name and case number of each patient along with the specific medium which had been given. The medium was administered intravenously by the investigator in approximately one minute, and each patient was kept under observation for a period of at least 15 minutes. During this period of time the patient was observed for the following signs and symptoms: nausea, vomiting, dizziness, flush, pruritis, hives, dyspnea, chest pain, hypotension, pallor, sweating, and arm pain.

Prior to the injection of the medium the patient was questioned as to any previous history of allergies, and an intradermal injection of 0.1 cc. of a 1:15 dilution of medium was given to those patients who gave a history of allergic manifestations such as hay fever, asthma, hives, drug idiosyncracies, etc. In all instances except one, those patients exhibiting a positive intra-

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Division of Urology, Henry Ford Hospital.
* Mallinckrodt Chemical Works.
† Winthrop-Stearns, Inc.
‡ E. R. Squibb & Sons.

dermal test were not given the medium. In the one instance where the patient was given the medium in the presence of a positive intradermal test, it was done by error, and the patient had no untoward reaction.

In most cases in which the patient gave a history of allergic manifestations and exhibited a negative intradermal test, 1 cc. of the medium was given intravenously, with a three- to 5-minute delay before the remainder of the medium was injected. Each patient was given an antihistamine preparation orally prior to the injection of the medium. Compression of the lower abdomen was used in all cases except where some pathological condition existed which prevented its use. All of the pyelographic films were graded by the members of the staff of the division of urology at the daily pyelographic conferences, without knowledge of which media had been used, according to the following system of grading:

Excellent: those films that exhibited filling of the renal pelves and ureters with the dye to such a degree that the films were of the same quality as satisfactory retrograde pyelograms.

Good: those films that exhibited filling of the renal pelves and ureters to such a degree that the study was entirely satisfactory for competent interpretation.

Fair: those films that exhibited filling of the renal pelves and ureters to such a degree that the reliability of interpretation was in question.

Poor: those films that exhibited such poor filling of the renal pelves and ureters that the study was unsatisfactory for any interpretation.

As may be seen in Figure 1, the quality of the films was not significantly different for any of the media tested. However, in the matter of reactions exhibited by the patient, as seen in Figure 2, results indicate that the percentage of patient reactions to the three newer media is significantly lower than that for sodium acetrizoate 50% and 70%. The fact that we could not control the number of patients with previous allergic manifestations resulted in a rather unequal distribution of these cases throughout the series. For example, the number of such patients given Renografin is almost three times the number given sodium diprotrizoate. Considering also the fact that 34% of those patients with allergic backgrounds had some kind of reaction, compared with 26% reactions in those patients

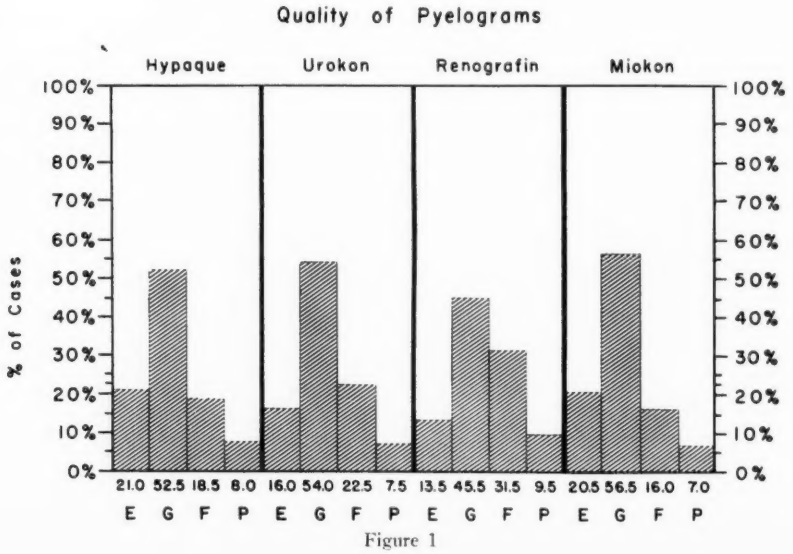

Figure 1

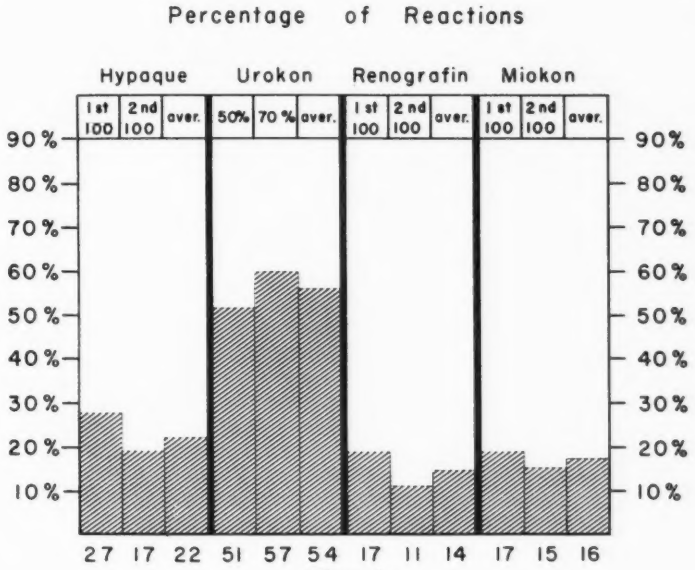

Figure 2

with no allergic history, it is possible that the reaction rate to sodium diprotrizoate would have been higher, and that to Renografin lower, had the same number of patients with allergic histories been included in each series.

It is obvious that the reactions which occurred (Table) were, for the most part, of a minor nature. Only one serious reaction occurred in this series. This was in a 4-year-old white girl who had no previous allergic history and was given 10 cc. of diatrizoate sodium intravenously in a period of one minute. She complained of nausea and chest pain shortly after the injection was completed and proceeded to vomit and

Reactions to Intravenous Pyelographic Media

	Ditrizoate Sodium		Sodium Acetrizoate		Renografin*		Sodium Diprotrizoate	
	1st 100	2nd 100	50%	70%	1st 100	2nd 100	1st 100	2nd 100
Previous history of allergy	12	9	9	17	18	10	5	5
Skin test	All neg.	All neg.	1 pos.	All neg.	All neg.	All neg.	All neg.	All neg.
Nausea	13	13	24	20	10	11	11	10
Vomiting	3	5	5	6	3	6	3	2
Dizziness	3	0	5	4	5	0	2	1
Flush	10	3	22	34	4	2	7	3
Pruritus	1	0	1	6	0	0	0	1
Hives	4	3	7	9	2	0	1	1
Dyspnea	0	1	1	0	0	0	0	0
Anaphylaxis	0	1	0	0	0	0	0	2
Sweating	1	0	1	2	0	0	1	0
Arm Pain	2	0	4	12	0	0	0	1
% of patients with some reaction	27	17	51	57	17	11	17	15

* A combination of the sodium and methylglucamine salts of ditrizoate.

develop giant urticaria over most of her body surface. Her blood pressure dropped to 40/0 mm. Hg, and she became dyspneic and exhibited a generalized flush. She was given 0.3 cc. of 1:1000 epinephrine intramuscularly and 4 mg. of chlorpheniramine maleate U. S. P. (Chlor-Trimeton) orally. Within a few minutes her blood pressure returned to normal, and during the next few hours she made a rapid and uneventful recovery. The two cases of "anaphylaxis" recorded for sodium diprotrizoate were listed because the patients complained of chest pain shortly after the administration of the medium. However, they did not exhibit any other signs or symptoms.

This study included only 200 cases of each medium, and therefore the results cannot be considered statistically valid. However, the fact that the same investigator administered the medium and made the observations in all cases renders the results which were obtained as uniformly accurate as possible, and, in this sense, the study may be of value in predicting the expected results as these media are given more general usage in the future.

Summary and Conclusions

A blind comparative study of 800 cases of intravenous pyelography with use of sodium acetrizoate (Urokon sodium) 50% and 70%, sodium diprotrizoate (Miokon sodium) 50%, diatrizoate (Hypaque sodium) 50%, and a combination of the sodium and methylglucamine salts of ditrizoate (Renografin) 76% is reported. The types and percentages of reactions and the quality of the resulting pyelograms are recorded. The results seem to indicate that there are significantly fewer reactions to be expected with the use of sodium diprotrizoate 50%, diatrizoate sodium 50%, and Renografin 76% than with the use of sodium acetrizoate 50% and 70%, whereas the quality of the resulting pyelograms is approximately the same for all of the media used in the study.

Pilonidal Sinus

Preliminary Report on a Fresh Approach

Col. WARNER F. BOWERS (MC)
and
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U. S. Army

Introduction

The literature on pilonidal sinus has assumed voluminous proportions, replete with many cryptic and esoteric allegations as to etiology. These range from the philosophical observation that pilonidal sinus is an atavism relating to the preen gland of birds [1] through the teleological assertion that the hairs grow inward and pull the hole after them.[2] How these hairs attain sufficient traction with their free tips to accomplish this is not stated by the proponents of this theory. Numerous papers * cite the tremendous cost in man-days from hospitalization of servicemen with this condition, while the incidence in civilian life is low. This means, in part, that soldiers are hospitalized for infections which could be treated by civilians in the home. To a greater degree, it means that soldiers in a barrack or field environment suffer somewhat in personal hygiene, and in addition they are exposed to greater trauma from truck and jeep riding. This increased incidence of hospitalization has led to a wide variety of advocated procedures, including unroofing,† excision and suture of skin edges to fascia in midline,‡ excision and open packing,§ employment of flaps of gluteal muscles or fascia,‖ use of rotated or sliding flaps of skin and subcutaneous tissue,¶ block excision and primary closure,# simple incision and drainage of abscesses as they develop,[3] and simple incision with insertion of the head of a mushroom catheter which is extruded as the wound heals from the depths.[21] The simple fact that so many varied procedures have been advocated by such a large group of authors is clear indication that no one procedure is outstandingly successful in avoiding morbidity and recurrent difficulty. Some authors [20] have emphasized the minutiae of preoperative and postoperative care; others have stressed the role of hemostasis in prevention of "recurrence," while still others urge the antibiotics as the key to good results. A common-sense note is sounded by one author,[22] who states that the operation itself is not so important as the care with which the procedure is done, and that, although there are more wound complications with the primary closure, the end-results are about the same whether an open or closed procedure is employed.

Until recently at Brooke Army Hospital we had been following the policy of incision and drainage of pilonidal abscesses, reserving an unroofing or marsupialization procedure for recurrent cases. Although the end-results have been entirely acceptable, a procedure employing primary closure

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† Capt. Williamson died July 8, 1956.

* References 2-4.

† References 5 and 6.
‡ References 7 and 8.
§ References 9-11.
‖ References 12-14.
¶ References 15 and 16.
# References 17-20.

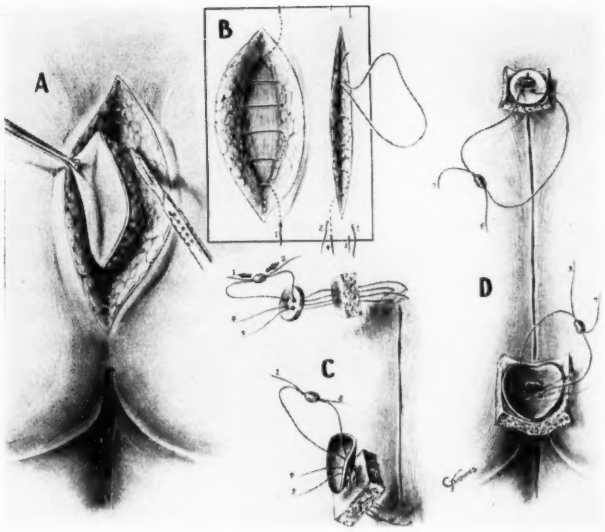


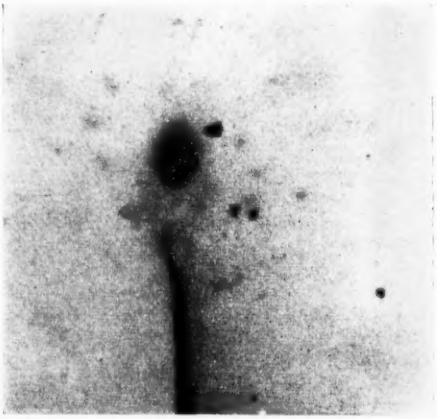
Fig. 1.—Details of the method. *A*, the lesion is excised down to the fascia with sacrifice of a minimum of skin. *B*, the deepest No. 28 wire suture is placed at fascial level in a running mattress type stitch and is brought out at each end through normal skin. *C*, the wires are brought through foam rubber and buttons after being pulled up tight and are maintained by crimped-on lead beads. *D*, the last wire suture is subcuticular in position. A few interrupted nonabsorbable surgical (cotton or silk) sutures may be used in the skin if desired, but are not essential.

would seem to offer better healing in a shorter time, provided that the usual difficulties of hematoma formation, wound disruption, and recurring infection could be controlled. We have not felt that the bacteriological problem was a primary one, and, therefore, we have placed no reliance on local or general use of antibiotics or other drugs. We have never believed that the operative failures were "recurrences" of the cyst or sinus but have always felt that these represented failures of good wound healing for a variety of reasons. These factors include poor local blood supply (often no bleeding points need control), motion of the parts as in walking and tension as in sitting, favorable environment for infection because of the proximity of the anus together with the natural warmth and moisture of the area, and especially faulty wound closure leaving dead spaces which result in hematoma accumulation, sinus formation with epithelization, and chronic infection in the granulating tract. Our effort, therefore, has been directed toward careful wound closure to avoid dead space and hematomas, the avoidance of suture material for hemostasis, and the use of wire sutures for accurate wound approximation, with "pull-out" when the wound is solid.

Method

In the face of the many operative procedures which have been advocated as the definitive answer to the problem of pilonidal sinus, it requires considerable temerity to suggest still another procedure. However, one of us (W. F. B.) felt that a primary-closure method would be a surgical procedure more likely to give a better end-result, that suture material should not be left in the depths of the wound, and that the problem of "recurrence"

Fig. 2.—Appearance of the external orifice of the pilonidal sinus seven days before operation.



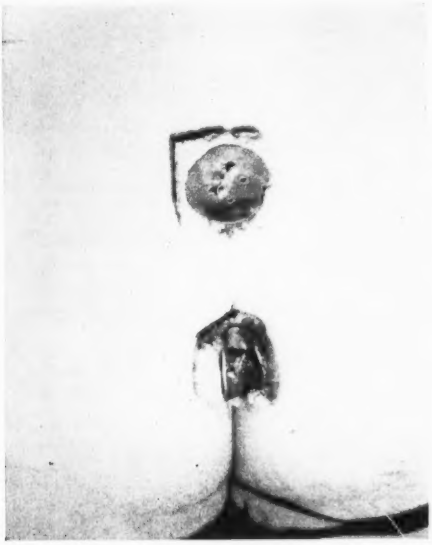


Fig. 3.—Ten days after excision and primary closure with longitudinally placed wire sutures tied over foam rubber and buttons.

Fig. 4.—Ten days postoperatively and immediately after removal of the four wire sutures.

could be solved by better and more accurate tissue approximation with a retaining suture until the healing was solid. The devised procedure, then, is as follows.

In the case with minimal acute infection, an elliptical excision is done, removing little skin and only enough tissue to remove completely all the lesion down to the fascia. The specimen is inspected and opened to be sure that no tract has been transected. Hemostasis is secured by temporary use of a moist, warm gauze pack. A No. 28 wire suture then is introduced at the lower angle of the wound through normal skin and is placed as a running mattress stitch the length of the wound in the manner of a subcuticular stitch. This suture is placed at the level of the fascia and is brought out at the upper angle of the wound through normal skin. Three more such continuous mattress wire stitches are placed in layers from deep to superficial, the last one being subcuticular in position. These stitches are pulled tight as they are placed, great care being taken to see that there are no remaining dead spaces. The wires then are passed through a small piece of sponge rubber and a button. A lead shot is crimped onto the wires as shown in Figure 1, and a small dry dressing is placed. Postoperatively, we allow the patient to assume any comfortable position, make no effort to inhibit bowel movements, allow the patient to be out of bed as soon as sutures are removed, and remove the wire sutures by the "pull-out" method at about 10 days if the wound looks clean and solid. Should there be some inflammatory reaction, there is no reason why the sutures cannot be left in place while this complication is managed by local application of heat. We have not used antibiotics either preoperatively or postoperatively.

Fig. 5.—One month after operation the patient is ready for duty.

TABLE 1.—*Preoperative Data*

Case No.	Age	Symptoms	Examination	Previous Treatment
1	24	Occasional serosanguineous drainage for several years, profuse 1 mo.; several episodes of pain, tenderness, and swelling, with occasional drainage of purulent material	5 small sinus openings in midline over sacrum from which protruded hair; mild tenderness; no induration or redness; small amount of serous drainage	Sitz baths
2	25	Pain, swelling, tenderness over midsacrum 7 days' duration	5×3 cm. area of redness, swelling, tenderness, with fluctuant center over midline midsacrum	Incision and drainage Jan. 13, 1956, followed by sitz baths 4-6 times daily
3	20	Pain and tenderness presacral area, with small amount of seropurulent drainage 4 days' duration.	Sinus opening midline over lower sacrum; small area of induration to left of opening; purulent material obtained on probing	Sitz baths 7 days prior to surgery
4	26	Recurrent episodes of pain, swelling, and drainage of serosanguineous material since 1952; increasing tenderness and drainage in recent months	Area of induration, reddened and tender about 7-8 cm. in length in midline over sacrum; sinus openings in each end of affected area; probe passed from one to the other	Sitz baths 9 days prior to surgery
5	24	Recurrent episodes of pain, swelling, and drainage of serosanguineous, purulent material	3×3 cm. area of induration, redness, and tenderness with 2 small sinus openings in midline; no drainage	Sitz baths 4 days preoperatively
6	39	Occasional tenderness 5 yr.; drainage 8 mo. ago of seropurulent material; tenderness, swelling, and drainage preoperatively 2 wk.	Small area of induration, tenderness surrounding sinus opening which was not draining	Sitz baths 8 months ago and just prior to entering hospital

TABLE 2.—*Postoperative and Follow-Up Data*

Case No.	Date of Surgery	Wires Removed, Postoperative Day	Complications	Complete Healing, Postoperative Days	Present Status	Hospital Days	Days Lost from Duty
1	1/ 6/56	10th	Mild amount of skin necrosis from pressure of lead pellets	18	No recurrence; asymptomatic; wound solid	31	45
2	1/23/56	10th	Mild amount of pressure necrosis of skin from lead buttons	28	No recurrence; asymptomatic; wound solid	41	41
3	2/15/56	7th	Foul-smelling discharge from wound 7th postoperative day; sutures removed and sitz baths started, with prompt healing	25	No recurrence; asymptomatic; wound solid	32	53
4	3/ 5/56	10th	Mild amount of pressure necrosis of skin from lead buttons	23	No recurrence; asymptomatic; wound solid	33	47
5	3/16/56	10th	Small amount of pressure necrosis from buttons	19	Healed; asymptomatic; wound solid	30	44
6	3/22/56	16th	On 8th postoperative day patient began draining small amount of purulent material; sutures left in place 16 days and drainage gradually ceased; on removing wires there was a small area, 2-3 cm. in length, at lower end of wound not healed, started on sitz baths	36	Healed; asymptomatic; wound solid	31	45

Summary of Cases

This preliminary report seems indicated because our first six cases have completely justified our original assumptions and expectations. The group is small, but the clinical results have been uniformly good, and our follow-up ranges downward from six months. Our only complication has been a small area of pressure necrosis in each case at the points where the wires emerge through normal skin, but this has not been a significant difficulty and has not interfered with solid wound healing. Each patient has been in the hospital about one month and has lost a total of about six weeks from duty. An extensive study of this subject, with development of a sizable series for comparison with our previous cases is

planned. Our preliminary case data are shown in the two tables.

Summary and Conclusions

In spite of voluminous literature and a variety of advocated procedures, pilonidal sinus remains a serious problem from the standpoint of repeated infections, extensive hospitalization, and postoperative failure of adequate healing.

We view the problem as a practical exercise in basic wound healing in which bacteria play a secondary role.

This is a preliminary report on a method of primary closure, avoiding all retained suture material in the wound and depending upon "pull-out" wire sutures placed in the long axis of the wound, rather than transversely. These sutures can be left in place until wound healing has been completed, even if infection supervenes postoperatively.

In a small series the results have met expectations and the short-term follow-up is encouraging.*

* In the interval following submission of the preliminary report, our case material has more than tripled. Two instances of wound infection have occurred, but no antibiotics were used, the wires were left in place, local heat was applied, and the infection cleared. The wires were removed in about 18 days, and healing was solid at that time. Follow-up has been entirely satisfactory to date.

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The Sympathetic Nervous System and Pulmonary Embolism

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The major cause of death in pulmonary embolism is the mechanical obstruction of blood flow through the lungs. In certain cases, however, it appears evident that the mechanical block is too small to account for death. It is possible that certain noxious reflexes may occur, such as pulmonary vasoconstriction, coronary vasoconstriction, reflex bronchial constriction, bronchial hypersecretion, and cardiac arrhythmia. The studies on pulmonary vasoconstriction have produced conflicting results, since most investigations require manipulations and anesthesia which result in serious errors of interpretation.

A method was developed wherein the pulmonary circulation was studied by embolizing the unanesthetized animal with 5μ size graphite particles and studying their distribution in the lungs.[1] In this manner it was demonstrated that pulmonary vasoconstriction was associated with minute pulmonary emboli and that it could be absolished by ether, pentobarbital (Nembutal), or atropine. Vagectomy did not change the vascular response.[2] It is the purpose of this investigation to utilize this method to study the role the sympathetic nervous system plays in pulmonary vasoconstriction associated with pulmonary embolism.

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Methods

Rabbits averaging 4 to 10 lb. were used as the experimental animals. A 0.48% solution of 5μ sized graphite particles (Dixon's Airspun Micronized Graphite, Type 200-09) was used for embolization in a dose of 1 cc. per pound of body weight. Polyoxyethylene sorbitan monolaurate (Tween 20) was used as a mixing agent for this solution. After or before embolization various drugs were used and at the end of 15 minutes the animals were killed and lung sections taken for microscopic study. The average number of graphite-filled blood vessels, 20μ or larger in diameter per low-power field, was used as an index of vasoconstriction. With vasoconstriction, the graphite particles collect in the arterioles, and the

Summary of Experimental Data

Drug	Dose	Rabbits, No.	Mortality, %	Arterioles/ Low-Power Field
Control		17	12	20.5
Tetraethylammonium (Etamon)	30 mg./kg.	14	7	3.7
Tolazoline (Priscoline)	25 mg.	12	0	3.8
Epinephrine	0.04 mg./kg.*	8	50	8.6
	0.01 mg./kg.*	8	13	4.0
	0.01 mg./kg.†	8	0	1.5
	0.01 mg./kg.‡	15	33.3	17.2
Epinephrine aerosol		8	0	4.7
Epinephrine	0.01 mg./kg.			
Tetraethylammonium	30 mg./kg.*	10	50	6.9

*Intravenously 10 minutes before embolus.
† Subcutaneous with embolus.
‡Intravenously simultaneous with embolus.

number of graphite-filled arterioles per low-power field is relatively high. In the absence of vasoconstriction the graphite particles diffuse into the capillaries, and the number of graphite-filled arterioles is low. In this manner the microscopic data can be presented in tabular form (Table).

Results

The control animals exhibited the usual vasoconstriction seen with multiple minute emboli. Tetraethylammonium (Etamon), a ganglion blocking agent, and tolazoline (Priscoline), an adrenergic blocking agent, produced a vasodilation. Epinephrine, an adrenergic agent, produced varying results, depending upon the dosage and upon the route of administration. Large doses produced a severe lung edema which obscured interpretation of the slides. Smaller doses of epinephrine administered by the intravenous route 10 minutes before embolization, by the subcutaneous route simultaneous with embolization, or by aerosol, produced a vasodilation. The same dosage administered intravenously simultaneous with the embolism produced a vasoconstriction. The combination of epinephrine and tetraethylammonium demonstrated vasodilation but proved to be a fatal combination.

Comment

Although the evidence is somewhat conflicting,[3] it appears that there is some sympathetic control of the pulmonary circulation. Daly and co-workers * have found that sympathetic stimulation in the perfused living animal and in the eviscerated animal produces vasoconstriction. Dirken and Heemstra [7] have demonstrated that bilateral sympathectomy increases pulmonary blood flow in the rabbit. However, a bilateral sympathectomy in dogs appears to have no effect on the hemodynamic alterations produced by pulmonary embolism.† The chief objection to the latter investigations is that they are performed on anesthetized animals.

The present study, using adrenergic blocking agents and ganglion agents, would indicate that abolishing the sympathetic activity in the lung produces a vasodilation in animals that have been embolized by minute emboli.

Epinephrine appears to produce a transient vasoconstriction of the pulmonary vessels. Using the transillumination method, Hall [12] and Irwin and co-workers [13] found that epinephrine produces arteriole vasoconstriction. In perfusion studies of rabbit lungs, Euler [3] found it produced a slight rise in pulmonary artery pressure. Daly [6] found that the size of the dose made a difference and that small doses produced a vasodilation in the cat, frog, and turtle, whereas large doses produced a vasoconstriction. Studies of isolated pulmonary vessels have revealed conflicting data, but, in general, epinephrine produces vasconstriction.‡ De Takats and colleagues [16] studied the effect of epinephrine on massive pulmonary embolism and found that it did not change the mortality rate but produced a marked pulmonary edema.

The present results with epinephrine bear out most of these conclusions. It would appear that there is a transient vasconstriction produced by epinephrine which gives way to a vasodilation similar to the effect of this drug on the vascular bed of muscle.[17] This may not necessarily be vasodilation. It is possible that after the transient vasoconstriction disappears, the pulmonary circulation is subjected to the elevated arterial pressure as occurs in similar experiments on the kidney.[18]

The increased mortality rate produced by the combination of epinephrine and tetraethylammonium was surprising until a study of the literature revealed that epinephrine also inhibits autonomic ganglion transmission, therapy potentiating the effect of tetraethylammonium.§

Summary

The results of studies on 5μ size emboli in rabbit lungs would indicate that there is sympathetic activity associated with embolism which can be blocked with tetra-

* References 4-6.

† References 8-11.

‡ References 6, 14, and 15.

§ References 19-21.

ethylammonium (Etamon) and tolazoline (Priscoline).

Epinephrine was found to produce a transient pulmonary vasconstriction in small doses yielding to a more prolonged vasodilation.

The combination of epinephrine and tetraethylammonium was dangerous, since epinephrine is a ganglion blocking agent and enhances the effect of tetraethylammonium.

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Cervical Rib Causing Gangrene and Necessitating Forearm Amputation

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Cervical ribs in humans have been described for many centuries. According to Edington,[4] the first recorded observation of this entity was probably by Galen. In 1742, Hunauld described a well-documented case of bilateral cervical ribs as an incidental finding. Since then, many writers have recognized the importance of this anomaly in cases manifesting peripheral neuritis, loss of strength, or vascular disturbances of the upper extremities. Extremely few cases have been reported where the vascular disturbances due to a supernumerary rib have become so severe that gangrene developed and subsequent amputation of the involved limb was required. G. Perazzo[6] (1933) reviewed 21 cases over the years 1815 to 1933 where gangrene of portions of the upper extremity occurred. He included a case from his own observation. Only four of these cases required amputation of portions of the upper extremities, ranging from the fingers to the entire upper limb. The first report in American literature was the case observed by Russell,[7] in 1907. Schiassi,[9] in 1921, Lavenant,[5] in 1923, and Perazzo,[6] in 1933 published the three additional cases in which amputation was necessary for gangrene due to vascular disturbances caused by cervical ribs. In their classical article about cervical ribs, Adson and Coffey[1] reported, in 1927, a case of amputation of the fingertips on a patient who died 15 days later from exanguination following subclavian hemorrhage. Donald and Morton[2] observed a man who had gangrene of the left upper extremity to such an extent that the urna and radius were freely exposed to the atmosphere below the midportion of the lower arm. The lower portion of the forearm and the hand were present as a mummified, blackened appendage when surgery was carried out in 1940.

Because of the rarity of this phenomenon and the dramatic consequences, we feel it is justified to add another case recently observed at the United States Naval Hospital, Portsmouth, Va.

Report of a Case

A 39-year-old right-handed Chief Boatswains Mate was apparently well until he developed a rather sudden onset of pain and coldness in the left hand and forearm without known precipitating cause. This become progressively worse over a three-week period, until he could no longer perform his duty, and he was admitted to the hospital on the Medical Service. There was no history of trauma. The hand and forearm were comfortable at room temperature and at rest but became painful upon exercise. Exposure to cold aggravated his symptoms. The dependent position also intensified the pain. There was nothing significant in the past history or system review except that on a routine chest x-ray in April, 1952, the presence of bilateral cervicle ribs was noted. He was a heavy smoker until one week prior to the apparent onset of his difficulty, when he decreased consumption markedly, to one-half package per day.

Physical examination on admission revealed a

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The opinions or assertions contained herein are the private ones of the writers, and are not to be construed as official or reflecting the view of the Navy Department or the Naval Service at large.

somewhat obese man complaining of pain and discomfort in the left hand and lower arm. The positive abnormal findings were limited to that extremity. There was coldness of the left forearm and hand, associated with marked tenderness and mild cyanosis of the first, second, and third digits. Upon elevation of the left arm, pronounced blanching of the hand occurred. The radial and ulnar pulsations on the left were barely palpable. Blood pressure on the right was 130/80; blood pressure on the left was not demonstrable. Hemogram, urinalysis, and Kahn were normal. Electrocardiogram revealed no abnormalities. X-rays of the chest and cervical spine again showed bilateral cervical ribs, the right one more fully developed than the one on the left (Fig. 1).

Fig. 1.—Chest x-ray showing cervical ribs.

The patient was given tolazoline (Priscoline) and treated conservatively for four days, during which time the cyanosis of the left hand became progressively worse, with marked increase in pain. A surgical consultation at that time noted that the left hand was markedly cyanotic and extremely tender to touch. Movement was limited to the functions of the long extensors and flexors. An immediate stellate ganglion block with 1% procaine was carried out, which relieved some of the pain and improved the color of his hand to some degree. Pulsations at the left wrist could still not be felt, but there was a palpable pulse in the subclavian artery, where it traversed the cervical rib. There were no palpable pulsations in the axillary or brachial artery. Following this the supraclavicular region on the left was explored through the classical anterior approach on Jan. 7, 1955. The scalenus anticus muscle, which was markedly hypertrophied, was sectioned at its tendinous insertion on the first rib. The subclavian artery was markedly constricted between the sides of a triangle formed by an osseous tubercle arising from the first rib posterior to the artery, the cervical rib, and the clavicle. The artery was swollen, edematous, and bluish in appearance. No pulsations were seen peripheral to this point. By retracting the artery anteriorly, three-quarters of the cervical rib with its tendinous attachment to the first rib was carefully rongeured away. Through the same approach, the upper portion of the sympathetic chain was then identified extrapleurally and the stellate ganglion excised. Following this procedure the artery seemed to be relaxed, and faint pulsations were seen below the level of the impingement. There was, however, no return of pulsations in the lower brachial artery or in the arteries at the wrist. The hand was warmer and less cyanotic than preoperatively. Approximately seven hours later, the cyanosis of the left hand and forearm again became progressively worse. A weak pulse was felt in the upper portion of the brachial artery but none below that level. Under general anesthesia, the midportion of the brachial artery on the left was exposed. On arteriography a complete block of the brachial artery at the midportion of the humeral shaft was visualized. An obvious obstruction could be palpated below that level. The artery was opened. A partially organized clot was found extending approximately 5 to 6 cm. distal to the site of obstruction. It was carefully extracted. Some bleeding from the distal segment was then encountered, and a tiny catheter was inserted for a distance of 26 cm. down into the radial artery. It was then withdrawn, irrigating the lumen of the artery with copious amounts of sodium citrate. The incision into the artery was then closed using arterial nonabsorbable surgical sutures (silk). When no palpable pulsations distal to this area were seen, the incision was reopened, and additional clots were washed out by means of a catheter. The incision was again closed, and adequate pulsations below the suture line were then present throughout the exposure. No palpable pulsations were present at the wrist. Immediately postoperative there was progressive recession of the amount of cyanosis and falling of the demarcation boundary between normal and cyanotic skin. Nevertheless, the tip of the thumb and, the second and the third digit became almost black, and the remaining fingers and hand, deeply cyanotic (Fig. 2). A line of demarcation now formed itself at the palmar crease of the left hand. Ten days after surgery the pain became increasingly severe. Large doses of narcotics failed to give relief. Swelling of hand and lower forearm occurred, and blisters

Fig. 2.—Showing marked cyanosis of thumb and index and middle fingers.

developed over the fingers. Three days later gangrene made it necessary to amputate the left forearm 18 cm. distal to the elbow. No primary closure was attempted. The stump did not heal. Thirteen days later a debridement was carried out, raising the amputation site an inch. The skin flaps were loosely closed with interrupted wire sutures, but the structures were still of questionable viability. Antibiotics were administered. Again gangrene developed in the stump in spite of scrupulous care. On April 20, 1955, three and one-half months from the date of admission, a redebridement of the amputation stump with shortening of the exposed radius and ulna was again performed under general anesthesia. The wound was left open for drainage. The patient's immediate postoperative status was excellent, and he was ambulatory within eight hours. Just before midnight of that same day, while sitting on the edge of his bed he suddenly complained of severe chest pain and shortness of breath. He gasped for breath and fell back onto the bed apneic. Emergency treatment was of no avail, and he died within a few minutes.

Autopsy.—There was evidence of arteriosclerotic cardiovascular disease. The cause of death was a recent, extensive myocardial infarction. The left ventricular wall was mottled and softened, with gross and microscopic alteration of the papillary muscles. No mural thrombus was present. In the left anterior descending branch of the coronary artery, 3 cm. distal to its origin, a fresh intraluminal antemortem blood clot was found. It occluded the vessel for 1.5 cm. The only other abnormalities were a rectal polyp, an anomalous (triple) renal artery, the amputation stump, the anomalous cervical ribs, and the brachial artery occlusion, to be described in greater detail. A 1 cm. residual stump of the left cervical rib was present. Just distal and inferior to it, the subclavian artery was constricted in the area that had been kinked over the supernumerary rib prior to surgery. Just distal to this region there was some aneurysmal dilatation of the axillary artery. The lumen was patent. The left brachial artery was narrowed for a 5 cm. distance. In the area of narrowing an antemortem thrombus was firmly adherent to the intima, starting about 3 cm. proximal to the site of arteriotomy and extending downward into the left radial and ulnar branches into the amputation stump. No sclerotic plaques were present in any of the arteries of the left arm.

Comment

Cervical ribs are not uncommon, being found in 0.03% to 0.1% of the general population.[1] The majority of these are incidental findings and produce no symptoms. In those patients who do manifest complaints, usually the discomfort is so mild that mere instruction as to prophylactic positioning is sufficient to relieve the pain. This helps all but 5% to 10%. Those who continue to be incapacitated by the symptoms of a cervical rib are either emotionally unstable persons who, because of psychogenic reasons, are unable to adjust to their mild discomfort, or those in whom the actual organic dysfunction is uncommonly severe. It would be a mistake, however, to dismiss all symptoms as "psychogenic." The disability can, on rare occasions, be of very dire significance, as illustrated by the case presented. Those cases reported earlier in the literature,[3] including the recent case of thrombosis of the internal carotid artery caused by a cervical rib,[8] again indicate this potentiality. When it becomes obvious that a serious complication from this anomaly is incipient, then immediate and adequate surgical intervention is necessary.

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Explosion-Proof Apparatus for the Treatment of Ventricular Fibrillation

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The incidence of ventricular fibrillation is increasing because of the large number of thoracic and cardiac procedures being performed. Many cases of ventricular fibrillation occur in one year in a large hospital and several times in one week in cardiac centers. Although the incidence of ventricular fibrillation is greater during operations on the chest, it may occur during any operative procedure and with any anesthetic agent. Consequently, it is important that the members of every operating team be able to treat ventricular fibrillation and standstill and that every suite of operating rooms have an electrical defibrillator.

The defibrillator should be simple in design and easy to operate and should deliver what appears at this time to be the optimal voltages at the optimal durations. The apparatus should be so constructed as to safeguard both the patient and the operating room personnel; of necessity, therefore, it must be explosion-proof. Because none of the defibrillators described heretofore fulfill these requirements, the following apparatus is being presented.

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Research Associate in Surgery, Harvard Medical School (Mr. Claff); Department of Surgery, Indiana University School of Medicine (Dr. Kaiser); Department of Surgery, Johns Hopkins University and Hospital (Dr. Gaertner); and Department of Surgery, University of Southern California School of Medicine (Dr. Kay).

Apparatus

The defibrillator has been designed to deliver three voltages. Each voltage, however, can be of only one duration. A tandem switch, with one knob adjustment, selects the voltage and at the same time a time duration. The voltages and durations selected are as follows:

130 volts A. C. for 1/4 second
220 volts A. C. for 1/10 second
280 volts A. C. for 1/20 second

The variac and isolation transformers have been eliminated and an electrostatically shielded transformer carries on their function. It increases an input of 115 volts A. C. to an output of 280 volts A. C. Taps are taken off the secondary at 130 volts and 220 volts—(Fig. 1.) The elimination of the variac that is used in other defibrillators has reduced a source of sparking caused by the rotating brush on the bare secondary windings. The elimination of the variac and the isolation transformer have substantially reduced the weight and size of the defibrillator.

Timing has been accomplished by using a small electronic component. This timing unit incorporates a voltage regulating tube and a circuit which requires no warm-up period.

We did not attempt to assemble a complete set of explosion-proof components but considered it more desirable to purge the entire instrument case with air. A small squirrel-cage blower which is operated by a ball-bearing motor brings the air in through a snorkel (Fig. 2). Since all the explosive anesthetic agents, except for ethylene, are heavier than air, the snorkel has been constructed so that when the apparatus is placed on a 32 in. table the snorkel extends slightly more than 5 ft. above the operating floor. A pressure greater than atmospheric is maintained in the case while the instrument is functioning. The air is discharged through louvers in the side of the case. The defibrillator may be operated by a panel switch or an explosion-proof electrical foot switch. The panel switch is automatically disconnected when the foot switch is connected.

Fuses have been discarded in favor of circuit breakers which can be quickly reset if necessary. Thus the fumbling and delay which might be caused by the changing of fuses during the emergency of ventricular fibrillation is avoided.

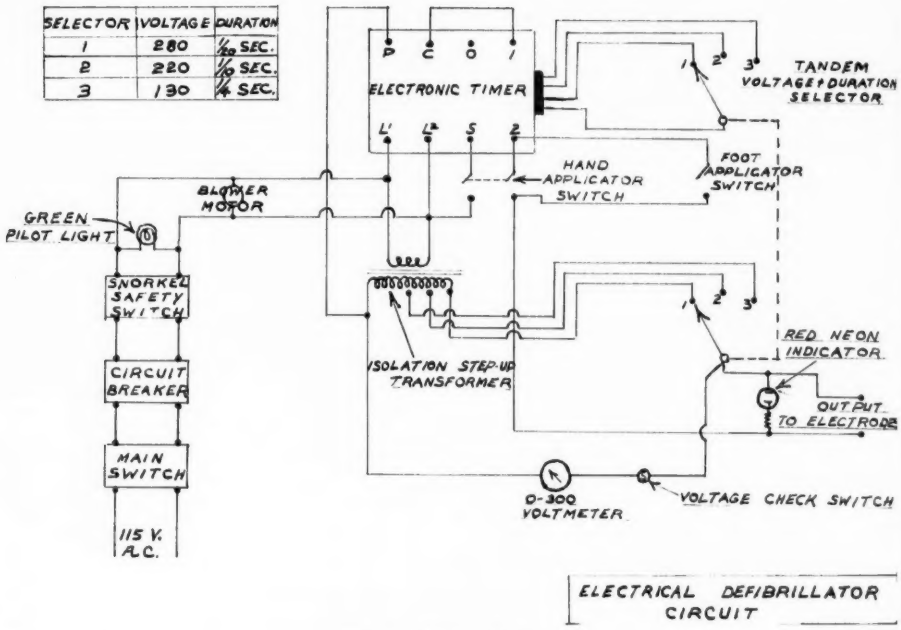


Fig. 1.—Wiring diagram.

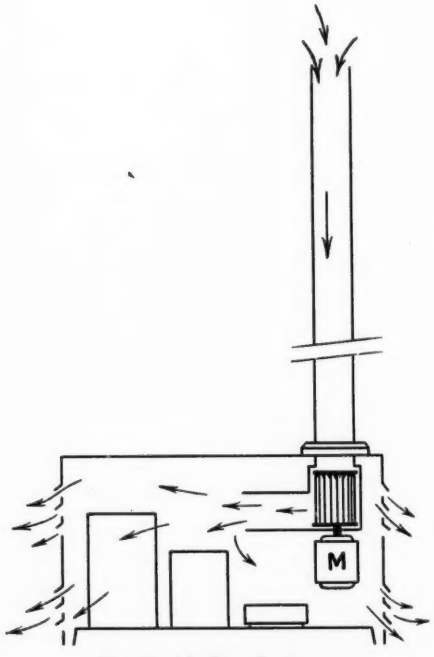


Fig. 2.—Air flow diagram.

Electrodes.—The electrodes consist of two stainless steel disch which are slightly concave. These discs are 60 mm. in diameter for adult hearts and 35 mm. in diameter for smaller hearts. The discs are attached to square plastic handles 21 cm. in length. The back of the electrodes is covered with a nonconductive plastic coating. The front of the electrodes is covered with a thick lintless cotton pad inserted in a cloth jacket and secured by a purse-string suture (Fig. 3). The electrodes are wired with Neoprene-covered #16 stranded wire. The entire electrode assembly can be autoclaved. The padded electrodes should always be soaked in saline before attempting electrical defibrillation.

Comment

Since Prevost and Battelli [1] first described the technique of electrical defibrillation, in 1899, it has been further refined and established as the approved method of defibrillation. Various voltages and duration have been recommended in the treatment of ventricular fibrillation. A direct relationship exists between the voltage and duration of shock for successful defibrillation. For a given voltage, if the duration is too short, defibrillation will not occur; if too long, the

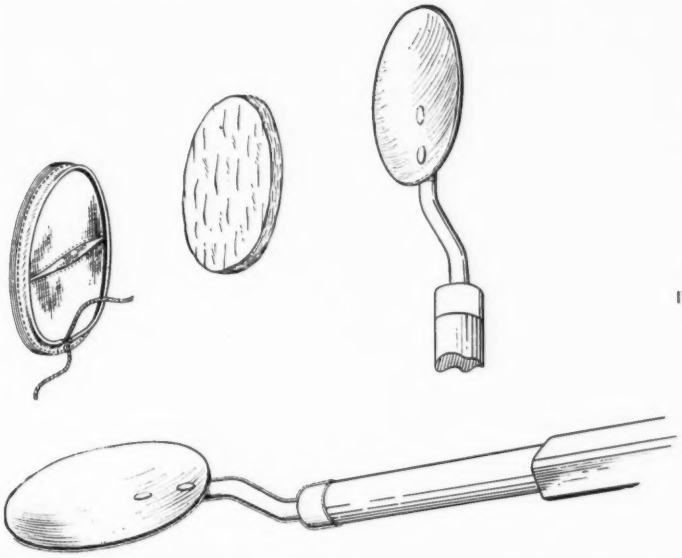


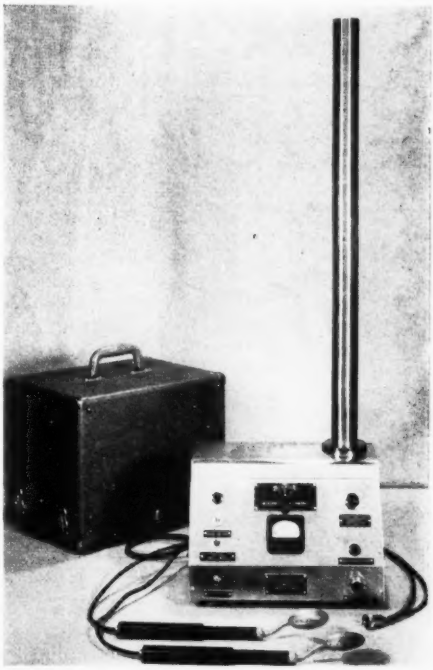
Fig. 3.—Electrodes and padding.

heart will be burned. As the voltage is increased, the duration must be decreased in order to avoid burning the heart. Experimentally, Kaiser, Edgcomb, and Kay [2] and Claff [3] have found the optimal voltages and durations to be 130 volts at ¼ second, 220 volts at 1/10 second, and 280 volts at 1/20 second. These voltages and durations appear to be most successful and usually do not inflict myocardial damage. By allowing only these voltages with these specific durations, one will achieve an optimal result with a minimal risk of trauma.

Cardiac resuscitation produces an atmosphere of tension. We feel at such a time a simple apparatus with a single knob selector for both voltage and duration is preferable to one with many dials which may add to the confusion and result in unfortunate human errors. The use of circuit breakers, instead of fuses, is important. These may be reset immediately; thus the necessity of replacing a fuse is avoided.

It is desirable to have an explosion-proof apparatus in the operating room. This may be attained by several different methods. All of the components can be made explosion-proof, but this procedure would make the weight and cost of the apparatus prohibitive. The equipment could be made explosion-proof by using an air tight case,

Fig. 4.—Photograph of explosion-proof defibrillator.



but this item also is extremely expensive. The simplest and least expensive method of making the apparatus explosion-proof is described in this article and consists of employing a squirrel-cage blower and a snorkel that allows purging of the unit with air taken from 5 ft. above the operating room floor.

Summary

A simple, easy-to-operate, explosion-proof electrical defibrillator is described. This defibrillator allows a choice of three voltages of predetermined durations which should allow maximum successful defibrillation with minimal cardiac damage due to burns. One-knob control of voltage and duration, a foot switch, and circuit breakers allow precise and almost errorless electrical defibrillation to be performed.

This apparatus was constructed for us by The Mark Company, Randolph, Mass.

Carl A. Moeller, Engineer, contributed to the design.

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Suture-Line Rupture of a Nylon Aortic Bifurcation Graft into the Small Bowel

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Resection of massive abdominal aortic aneurysms and substitution of synthetic grafts, dramatic as it may be, is now a well established life-saving and life-prolonging procedure. The indications for such surgical intervention are not as yet clearly delineated. The ultimate fate of the graft is not known with certainty; however, sufficient time has now elapsed to conclude tentatively that the newer synthetic materials appear to be quite satisfactory. The technical difficulties in this reported case will be apparent as it is reviewed. The operative task was one of herculean proportions, and was successfully accomplished by Dr. Henry T. Bahnson, of The Johns Hopkins Hospital. Since the number of patients subjected to such surgical procedure is increasing and because of the puzzling diagnostic problem involved in this instance, it was believed that a report of an isolated occurrence of this type warranted dissemination.

Report of Case

A 66-year-old white man was admitted to this hospital on March 30, 1954, complaining of a mass in the right abdomen which he had discovered three days earlier. There were no other symptoms. He was previously a patient here in May of 1953, at which time he was found to have arteriosclerotic heart disease with electrocardiographic evidence of an old extensive anterior wall myocardial infarction. From the history given at that time, the infarction was believed to have occurred in 1949.

Physical examination revealed a tall, somewhat obese, elderly white man who appeared chronically ill. Blood pressure was 176/140 in the left arm and 176/146 in the right arm. The heart was slightly enlarged to the left. There was a large, oval-shaped mass, measuring 19×18 cm., extending from the right subcostal margin well into the right iliac fossa. The left border extended well to the left of the midline. The mass was smooth, elastic, pulsatile, and expansile. The remainder of the physical examination was essentially negative. X-ray studies of the mass showed it to measure 18 cm. in diameter. There was some calcification along its inferior borders. The appearance was consistent with a large aneurysm of the abdominal aorta. He was transferred to The Johns Hopkins Hospital for definitive surgery.

On June 26, 1954, a letter received from Dr. Bahnson of The John Hopkins Hospital stated that the aneurysm had been excised and replaced with a bifurcation type nylon graft. The postoperative course was stormy, with embolizations occurring in the right femoral and later the right popliteal arteries, both being successfully treated by embolectomy. However, a dry gangrene of the first three toes of the right foot developed. It was the opinion at The Johns Hopkins Hospital that the preferable course was to wait for spontaneous amputation. He was subsequently discharged and three days later, on June 29, 1954, reentered this hospital.

With local surgery and careful medical management the foot slowly healed during the next 12 months. He was fitted with a special shoe and permitted to walk with the aid of crutches. On Nov. 13, 1955, he suffered an episode of weakness and faintness followed by a large bloody red stool. There was no pain. Thereafter he had a series of similar episodes of gastrointestinal bleeding, usually several days apart, one of which required the replacement of 3000 cc. of blood. None of these episodes was accompanied by pain. Proctoscopic examination and repeated barium studies of the entire gastrointestinal tract were not revealing except for the possibility of multiple polyposis of the colon. This diagnosis, however, was

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From the Medical Service, Veterans Administration Hospital.

not firmly established. At 7:30 a.m. on Dec. 14, 1955, he complained of severe abdominal and back pain; he went rapidly into profound shock and died about one hour later without responding to arterenol and blood transfusions.

Necropsy findings were as follows (Dr. Cardwell): The distal 10.5 cm. of the aorta, the proximal 3.5 cm. of the right iliac artery, and the proximal 1.5 cm. of the left iliac artery had been previously removed and replaced by a nylon graft which was intact. The lower end of the nylon graft was bifurcated and attached to the iliac arteries. Within the graft and lying on the posterior surface was an old brownish friable thrombus which formed a thin layer here. This did not obstruct the lumen. Surrounding the graft there was a thick tube of dense brownish-yellow scar tissue. In the upper portion the suture line connecting the graft with the aorta was intact, as was the suture line connecting it with the left iliac artery. At the suture line in the midanterior portion of the junction with the right iliac artery, there was a defect in the wall immediately beneath the graft. This was 0.3 cm. in diameter and communicated with an opening in an adherent loop of ileum about 2 ft. (61 cm.) above the ileocecal valve. This loop was densely adherent to the area over the upper part of the right iliac artery, but there were no other peritoneal adhesions. The lower part of the ileum and the entire colon were distended with a large amount of clotted blood.

Microscopic sections showed the ascending aorta to be normal histologically. In the section taken from the junction with the upper portion of the graft, the wall of the aorta was made up almost entirely of scar tissue with only a few scattered smooth muscle cells. There was a large amount of dense fibrous tissue on the inner surface which apparently represented the subintimal tissue. An old bleached-out thrombus was present on the inner surface here. Considerable suture material partly surrounded by foreign-body giant cells was seen in this area, and there was extensive calcification. The iliac artery at the site of rupture was similar. The ileum was intimately fused to the artery, and at the site of perforation it was covered by granulation tissue which was densely infiltrated by polymorphonuclear leukocytes. There was an old thrombus on the surface here. The tissue which was present about the graft was made up of dense scar tissue containing a moderate amount of old blood pigment. The section taken of one of the iliac arteries at a considerable distance below the graft showed very pronounced atrophy of the muscular coat and marked thickening of the subintimal fibrosis tissue with considerable lipoidal infiltration.

Other autopsy findings were as follows: (1) moderate left ventricular cardiac hypertrophy (weight of heart 440 gm.); (2) an old organized infarct of the left ventricular myocardium; (3) pronounced coronary arteriosclerosis, and (4) moderate obesity.

Comment

The introduction of methods of preserving aortic homografts in tissue culture medium [1] and by freeze-drying [2] ushered in a new era in the surgical treatment of abdominal aortic aneurysms and has rendered obsolete previous methods such as wiring, ligation, endoaneurysmorrhaphy and reinforcement with fibrogenic plastic materials. Blakemore and Voorhees [3] introduced synthetic fabrics for prosthetic replacement of excised arteries. These materials include nylon, Vinyon "N," Dacron, and Orlon [4] and are inexpensive, sterilizable, and easily procurable. Deterling and Bhomslay [4] report the combined clinical experience at the Presbyterian Hospital, New York, with more than 70 grafts of synthetic fabrics in the aorta and peripheral arteries. Their cases have been followed up to two years and include 11 patients with arteriosclerotic abdominal aneurysms on whom replacement of the aortic bifurcation was performed. There were two deaths in the immediate postoperative period, neither of which was due to rupture of the graft. The remaining patients have survived and have shown satisfactory functional results. Shumacker and King [5] used nylon replacement grafts in six cases of abdominal aortic aneurysm. There were two deaths in the immediate postoperative period, neither of which was due to rupture of the graft. The surviving patients showed a patent and well-functioning aortic pathway. There are two reports in the recent literature of fatal rupture of a reconstructed abdominal aorta. Hamblin and Lord's case [6] ruptured on the eighth postoperative day through the proximal and middle thirds of the homograft into the retroperitoneal space. Movins'[7] patient, who also had a homograft, developed a rupture into the peritoneal cavity on the tenth postoperative day at the superior suture line. To our knowl-

edge there are no reports in the literature of a rupture or leakage of an aortic graft into the intestinal tract such as occurred in our case.

It is also remarkable that our patient developed signs of leakage into the intestinal tract approximately 17 months after excision of his abdominal aneurysm and replacement with a nylon bifurcation graft and that he continued doing so intermittently for 1 month before his final and fatal hemorrhage. It is obvious, that had the nature of the bleeding been recognized, ample time was afforded for a possibly successful surgical attack at the site of perforation.

Leakage of an abdominal aortic aneurysm before operation is a well-recognized complication. Crane,[8] in his analysis of 44 cases of abdominal arteriosclerotic aneurysms from the files of the Peter Bent Brigham Hospital, Boston, finds that of the 15 aneurysms that ruptured, only 3 patients died within less than six hours of hospital admission. Five survived for from 12 to 24 hours, and the remaining seven for 1 to 6 days. He makes a plea for prompt diagnosis and urgent treatment during this period of bleeding It is of interest that only one of the aneurysms in Crane's series leaked fatally into the gastrointestinal tract (duodenum).

The outlook of patients with arteriosclerotic abdominal aneurysms is very discouraging. Estes[9] reviewed 102 cases of abdominal aortic aneurysm from the files of the Mayo Clinic. Ninety-seven cases were considered to be due to arteriosclerosis. Of the patients, 67% survived one year or longer, 49.2% survived three years or longer, and only 18.9% five years or longer. Survival rate of these patients was much lower than that of a similar group of normal people of the same average age (65). Of the 49 patients, 63.3%, in whom the cause of death could be ascertained died from rupture of the aneurysm. From a statistical analysis of Estes' data, Bahnson * concludes that one of five patients with an abdominal aortic aneurysm will die of rupture of the aneurysm within one year and that half will die within five years. Kampmeier[12] published a series of 73 cases of abdominal aortic aneurysm, 57.3% of which were syphilitic, in contrast to Estes' series in which practically all of the aneurysms were arteriosclerotic. Thirty-one of thirty-eight of his patients died of aneurysmal rupture.

Despite the fatal termination of our case 17 months after surgery, the newer techniques, utilizing homografts and grafts fashioned out of synthetic fabrics, offer renewed hope to this unfortunate group of patients.

* References 10 and 11.

Summary

A case of a fatal perforation of a nylon bifurcation graft into the lower gastrointestinal tract in a 66-year-old white man is presented. The patient survived excision of a huge abdominal aortic aneurysm and replacement with a nylon graft for one and one-half years. There was leakage of blood into the gastrointestinal tract for approximately four weeks before the terminal and fatal hemorrhage. At autopsy a perforation was found at the suture line of the graft and the right common iliac artery into a loop of adherent ileum. This is the first reported case of rupture of an abdominal aortic replacement graft into the gastrointestinal tract. The prognostic considerations of abdominal aortic aneurysms are briefly reviewed.

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Tietze's Syndrome

A New Entity in the Differential Diagnosis of Anterior Chest Wall Swelling

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The disease of Tietze or Tietze's syndrome was first described in a German medical report in 1921.[1] It manifests itself by a usually unilateral, painful, benign, smooth, nonsuppurative swelling of the sternoclavicular or first to sixth sternocostochondral junction. Its etiology is unknown. Only three publications * on this subject, reporting 11 cases, have appeared in the American literature, all three during the past three years, whereas the total number of reported cases in the foreign literature exceeds 100 cases. It therefore seems justifiable to direct more attention to this entity in the differential diagnosis of anterior chest pain and chest wall swelling.

Report of Cases

CASE 1.—A 35-year-old married white woman was first examined in February, 1952, because of a painful swelling involving the left first costosternal junction and present for the preceding two weeks. The pain radiated into the left shoulder and arm and was continuously present. There was no history of rheumatoid arthritis, and systemic review was negative except for cholelithiasis. Examination revealed a tender swelling of the left first costochondral junction without erythema or skin temperature changes. X-ray examination was entirely negative. Basal metabolic rate was +12. Red blood cell count was 4,000,000; white blood cell count was 9,600; hemoglobin, 12.2 gm. per 100 cc.; 2 eosinophiles; 46 neutrophiles; 52 lymphocytes. Sedimentation rate was 18 mm. in 60 minutes (Wintrobe). Total cholesterol was 143 mg. per 100 cc., uric acid, 2 mg. per 100 cc. Cold agglutinations were negative. Urinalysis was normal. Patient was started on salicylates and heat treatment with slight improvement. The episodes of painful swelling recurred about every eight weeks all year round and would last for two to three weeks. During the preceding 12 months there was also some involvement of the right first sternocostal junction, however, the swelling and pain was less pronounced on the right side. Repeated hematologic and blood chemistry determinations showed no changes from the original normal values. On the last x-ray films taken, in April, 1956, a slight increase in calcification in the cartilage was noted. The patient's condition is at present unchanged after four years of observation and symptomatic treatment.

CASE 2.—A 26-year-old married white woman was seen in February, 1955, complaining of localized pain and swelling of the right anterior chest wall. She had noted a knot just medial to the right breast in the past two weeks. Past history and systemic review were noncontributory. On examination we found the right third costochondral junction to be prominent and tender. There were no skin temperature changes. X-ray examination of the costochondral joints was normal. Hematologic survey showed 3,800,000 erythrocytes; 7900 leukocytes; 12.3 gm. hemoglobin; 2 eosinophiles; 54 neutrophiles; 44 lymphocytes. Sedimentation rate was 12 mm. in 60 minutes (Wintrobe). Urinalysis was negative. Cold agglutinations were negative. Because of persistent pain, a biopsy of the involved cartilage was taken four months later, at which time hydrocortisone (Hydrocortone) was injected into the operative area, but without relief of symptoms. The pathology report revealed only hyalinized fibrous tissue and cartilage. To date the patient still has symptoms at irregular intervals.

CASE 3.—A 29-year-old married white woman was admitted in December, 1954, for diagnostic studies, with chief complaint of pain, swelling, and soreness in the anterior chest wall. Patient had noticed a dull aching sensation in the presternal region off and on for the past year. Past history was negative. Examination revealed marked tenderness and bulging of both second sternocostal junctions. There were no overlying skin changes. X-ray examination was negative. Electrocardiogram and gastrointestinal series were normal. Basal metabolic rate was −20; 3,800,000 erythrocytes; 5500 leukocytes; 11.5 gm. hemoglobin; 2 eosinophiles; 60 neutrophiles; 38 lymphocytes. Sedimentation rate was 14 mm. in 60 minutes (Wintrobe). Urinalysis was normal. Pa-

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* References 2-4.

tient was treated with heat application locally and thyroid extract with fair results. She was discharged unimproved.

CASE 4.—A 25-year-old married white woman was seen in April, 1955, complaining of a painful swelling of her left sternoclavicular junction, present for the preceding six months. The pain, at first dull and intermittent in character, radiated into the left shoulder and arm. Systemic review was entirely negative. X-ray examination of the sternoclavicular junction was negative. Hematological survey showed 4,200,000 erythrocytes; 5600 leukocytes; 12.6 gm. hemoglobin. Sedimentation rate 14 mm. in 60 minutes (Wintrobe). Total cholesterol 180 mg. per 100 cc.; uric acid 2.2 mg. per 100 cc. Urinalysis was normal. Cold agglutinations were negative. The diagnosis of Tietze's syndrome was made, and the patient assured of the benign character of the lesion. Patient was treated with repeated local procaine injections and salicylates. On this symptomatic treatment she gradually improved.

None of our four patients showed any specific x-ray, hematologic or blood chemistry changes. Biopsy done in one case showed normal cartilage. In view of the presence of lymphocytosis in all four patients, cold agglutination tests with patients' sera were done in order to rule out virus infections as etiological or concomitant factor. No cold agglutinins could be demonstrated. The therapeutic effect of salicylates, local heat, procaine, and hydrocortisone injections was moderate.

Comment

The site of predilection in Tietze's syndrome is the left second sternocostochondral junction (35%),† followed by the right second sternocostochondral junction in about 30% of cases. Bilateral or multiple involvement, i. e., the second plus one or more other costal cartilages, occurs in 15%. Involvement of the sternoclavicular joint was reported by Tietze and Wehrmacher and also occurred in our fourth case. Both sexes were equally affected. Tietze's original four patients were three women and 1 man. Of Bruin's[6] 11 patients, 9 were women, and Laake[7] gives a similar percentage. Beck's 4 patients represented 3 women and 1 man, and Motulsky's and Wehrmacher's four cases consisted of two men and two women each. Geddes' and also Gill's[8] reports from the Allied Forces in World War II were limited to men. Satani's[9] nine patients were women, as are our four cases. All races are affected. Reports include whites, Negroes, Latin-Americans, Japanese, Hindus. The syndrome occurs in all age groups, with a preference for the second and third decade, and much more frequently than the scarcity of references suggests.

The clinical symptomatology is typical and consistently uniform. A sudden or gradual onset of anterior upper chest pain, associated with swelling of the involved costal cartilage. The pain usually is intermittent and lasts from a few days to weeks, while the swelling persists for months to years. The course of the disease is characterized by exacerbations and remissions. The palpable mass may bulge 0.5-3 cm. over the involved site. There is no erythema, no collateral circulation or regional lymphadenopathy, no abnormal joint mobility, and the skin over this area is freely movable. Radiological findings are normal except for occasional reports of fibrosis and increased calcium deposits in the affected cartilage.‡ This, however, is also seen in normal persons. In a number of instances in which exploration was done and biopsy obtained,§ no definite pathologic changes were encountered, and the complete absence of any inflammatory changes in the cartilage or overlying soft tissues was striking. Haas[11] considered the occasionally reported findings, such as hyperplasia and metaplasia of the cartilage with early bone formation and perichondral thickening, as normal variations of the rib cartilage.

Blood chemistry studies show normal values of calcium, phosphorus, and alkaline and acid phosphatase. Haas observed, however, in all his eight patients an increased uric acid level (4-5 mg. per 100 cc.) and a total cholesterol content of 300-400 mg. per 100 cc. The peripheral blood eosinophilic count was also increased (4%-7%) in the absence of intestinal parasites. None of his

† References 5 and 6.

‡ References 1, 8, and 10.

§ References 1-3, 5, 6, and 8-13. Himei Numata, cited by Leger.[12]

patients suffered from gouty arthritis, and instituted gout therapy showed no results. We were unable to confirm these findings in our four patients.

The etiology of Tietze's syndrome is unknown. Various theories have been advanced, which could not be proved by subsequent investigation. Tietze originally suggested dystrophy of the cartilage due to malnutrition or tuberculosis. Japanese authors || also seemed to favor malnutrition as an etiological factor, in contradistinction to Gill and Geddes, who reported 35 cases in Canadian soldiers, all in excellent nutritional state. Motulsky noted that frequently upper respiratory infection preceded the onset of symptoms and advanced the theory that chronic mild trauma, as occurs in paroxysms of coughing, may be the responsible cause, and also considered rheumatoid arthritis. Beck and Berkheiser believe that the entity Tietze's disease is not one involving the cartilage but rather an inflammatory reaction of the interarticular sternocostal ligament, which results in shortening of the involved ligament with buckling of the adjacent cartilage and anterior rotation. They noticed, as had Tietze, hypertrophy of the ligament, but unfortunately no ligament biopsy was obtained, although the cartilage itself was resected. The observation of Gomar Guarner,[13] who reported fibrosis of the ligament, would support their view. The preference for the second sternocostal junction may be explained on an anatomical basis. According to Spalteholz,[14] the interarticular sternocostal ligament is a fibrocartilaginous layer, which divides the second costosternal joint (synarthrosis) into two equal halves, whereas the other involved joints are only incompletely divided. This also accounts for the smaller degree of swelling when these joints are affected. In establishing the diagnosis of Tietze's syndrome, a variety of disorders has to be excluded, such as breast carcinoma, chest wall neoplasms, osteomyelitis of the ribs of pyogenic, tuberculous, or typhoid origin, syphilitic periostitis, mediastinal tumors, aneurysms, occult rib fractures, Hodgkin's disease, lymphomas, chondroma, Kahler's disease, and plasmocytoma. Presternal edema following mumps, intercostal neuritis, contusion, chest deformity, and rheumatoid arthritis also have to be considered in the differential diagnosis, the latter always affecting multiple joints. Tietze's disease can be distinguished from these conditions by adequate roentgenologic, bacteriologic, histologic, chemical, and serologic procedures and its almost uniform symptomatology. The treatment of Tietze's syndrome is mainly symptomatic, i. e., analgesics, salicylates, local heat application, and reassurance to the patient. Local procaine injections may be of temporary value. X-ray therapy to the involved site is not recommended, and resection of the cartilage has been performed as a last resort in a few persistent cases, with complete cure.

|| Reference 9. Himei Numata, cited by Leger.[12]

Summary

Four cases of Tietze's syndrome are presented. The symptomatology, clinical characteristics, differential diagnosis, etiology, and treatment are discussed, and the benign nature is stressed. The relative frequency of Tietze's syndrome necessitates inclusion of this entity in the differential diagnosis of anterior chest wall swelling.

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Variations in the Terminal Portion of the Human Thoracic Duct

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Many modern surgical procedures involve the area near the distal portion of the thoracic duct, in both the neck and the upper mediastinal area. The distal portion of the duct is the most commonly injured, resulting in either a chylothorax or a chylous fistula unless recognized at the time of injury and repaired. Such injuries have been reported as complications of block dissections in the neck for tuberculous nodes or malignant tumor, scaleniotomy, esophageal resection, the Blalock operation for congenital pulmonary stenosis, radical breast amputation, operation for left-sided torticolis and during left phrenicoexeresis.*

Anatomical studies have indicated that variations occur which may account for some of the injuries.[9] Methods used to investigate the variations have included x-ray visualization of the duct[18] and cadaver dissections.†

Seventy-five cadavers used for anatomical dissection by the medical students of the University of Tennessee during the years 1950 through 1953 were studied for variation of the terminal portion of the thoracic duct. With each dissection an illustration was prepared recording the relationships of the duct, particularly in the superior mediastinum and in the neck, and the manner in which the duct terminated.

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* References 4, 5, 8, 15, 17, 21, and 22.

† References 9 and 20.

In each instance the thoracic duct was located in the posterior mediastinum. The duct ascended along the right of the midline to the level of the beginning of the arch of the aorta. Here the duct crossed to the left and rose in the superior mediastinum posterior to the esophagus to enter the root of the neck. In one instance, however, the thoracic duct remained on the right side and emptied into the right internal jugular vein in the neck.

There were a number of variations in the relationship of the thoracic duct to the large veins and arteries in the root of the neck. In 74 instances the duct rose into the neck by passing posterior to the left innominate vein. In 49 of these the vessel coursed posterior to the left common carotid artery (the one emptying on the right passed posterior to the right common carotid artery). In 25 dissections the duct passed anterior to the internal jugular vein toward its termination.

The greatest number of variations were found in the pattern and site of termination of the duct into the venous system. In 45 instances the union took place with the left internal jugular vein as a single termination. The site of anastomosis of the duct with the vein was in itself variable (Table 1, Fig. 1). In addition there was an anastomosis by multiple terminations in three instances involving the internal jugular vein: one instance of two terminals into the anterior surface; another wherein there were three terminals entering the medial surface of the internal jugular vein, and one instance wherein one terminal entered the lateral surface of the internal jugular vein.

In the 26 dissections wherein the thoracic duct did not join the left internal jugular vein, venous connections were made with

TABLE 1.—*Termination of Thoracic Duct by Single Head into Internal Jugular Vein*

Point of Emptying	Number
Anterior surface	5
Posterior surface	3
Lateral surface	11
At junction with subclavian (lateral surface)	19
At junction with innominate (medial surface)	7
Total	45

the subclavian, innominate and external jugular veins. In 17 of these, the union was with the left subclavian vein between the internal and external jugular veins. In one, the junction with the subclavian vein took place lateral to the entrance of the external jugular vein. In five, the thoracic duct joined the external jugular vein predominantly at the angle formed by its entrance into the subclavian vein. In two, the anastomosis with the external jugular vein was at a higher level, where it entered the vein on its medial surface. The least common side of connection of the duct was with the innominate vein, one instance, where it entered the posterior surface of the vein (Fig. 2).

In addition to variations in site of termination, there were also observed a varying number of terminal ends of the duct itself

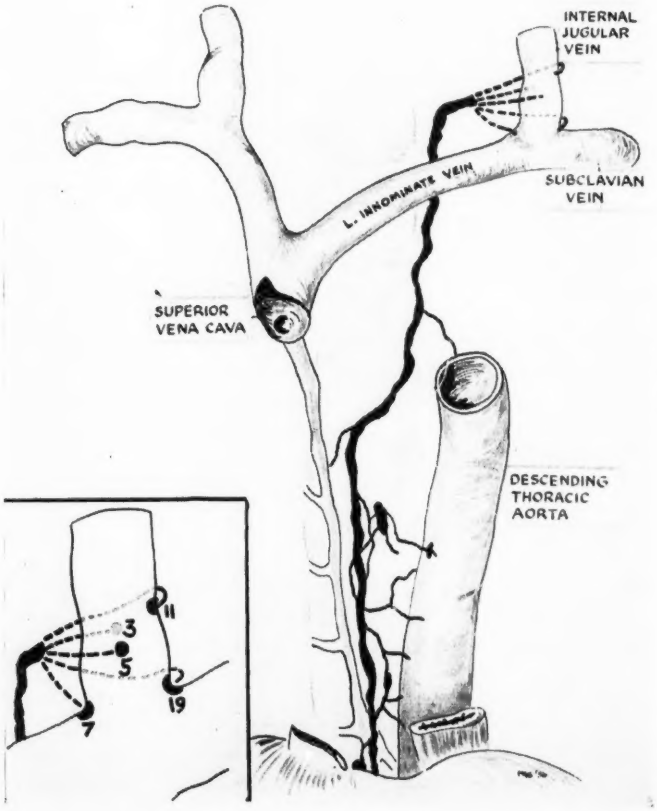

Fig. 1.—Showing variation in the site of termination into the left internal jugular vein of the 45 single-headed thoracic ducts (inset shows number of each).

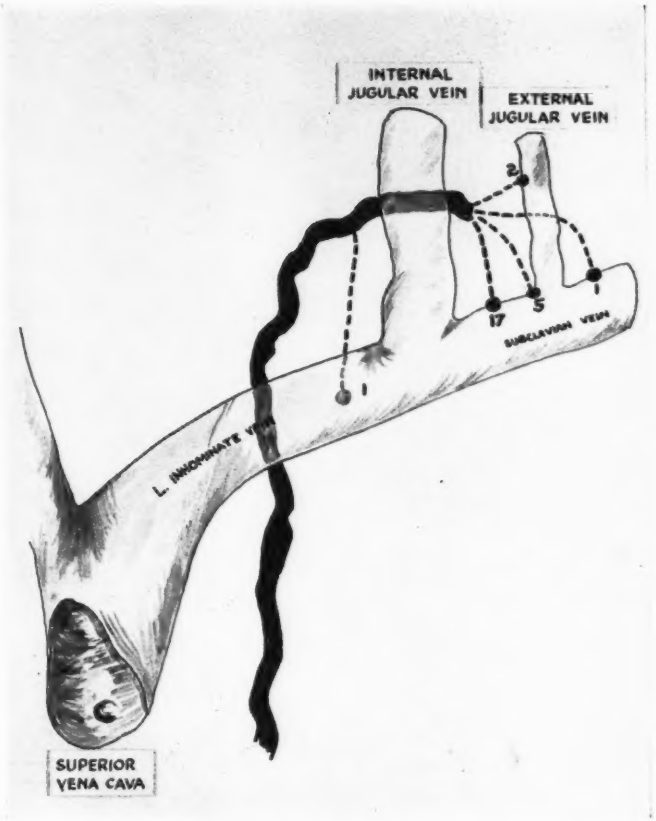

Fig. 2.—Showing variation in site of termination of 26 single-headed thoracic ducts other than into left internal jugular vein.

TABLE 2.—*Variation in Number of Terminal Heads in the Seventy-Five Cases*

No. of Terminal Duct Ends	Incidence, per Cent	Sites of Anastomosis
1	89.4	Innominate, internal jugular, external jugular, subclavian
2	6.6	Internal jugular, subclavian
3	4.0	Internal jugular, subclavian

(Table 2). Whereas 89.3% had one termination, 6.6% had two, and 4% had three terminal branches (Fig. 3).

Comment

Studies of variations in anatomical structure, not necessarily anomolous, have interest both to the academic or scientific study of anatomy and to the surgeon who encounters these structures in his work. An awareness of possible variations on the part of the surgeon may make it possible to avoid or to recognize injury to the structures involved. Thus, studies of this type have influenced biliary,‡ sympathetic nerve,[19] portal venous,[11] hernia,§ and other types of surgery.‖ Although the number of specimens involved in this study is not particularly large, the variations are in agreement with other studies.¶

‡ References 14 and 16.
§ References 1-3.
‖ References 6, 7, 10, 12, 13, 19, and 23.
¶ References 9, 18, and 20.

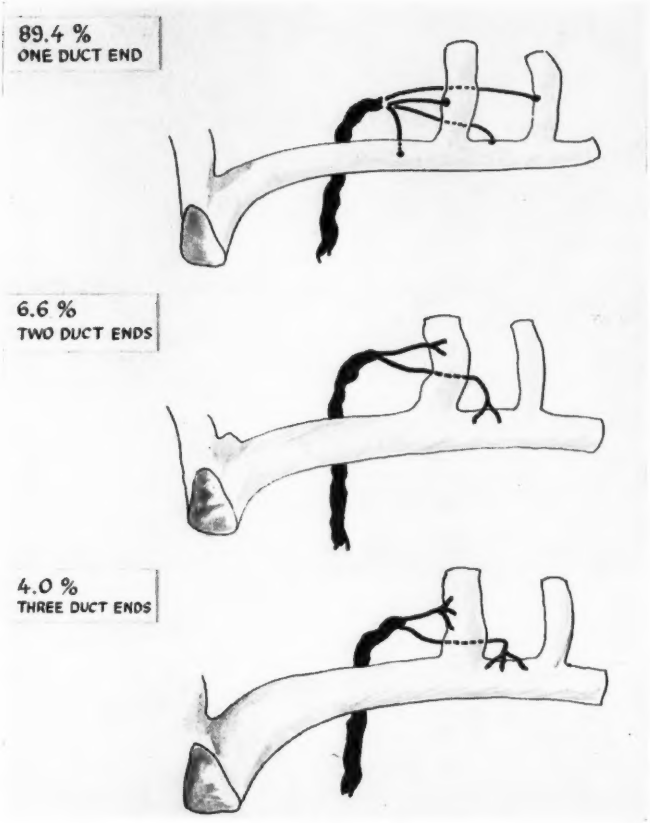

Fig. 3.—Showing variations in number of duct ends.

Summary

The terminal portion of the thoracic duct was studied in 25 cadavers.

Variations in the manner of termination and number of terminations of the end of the thoracic duct were found and described.

Awareness of these variations adds to knowledge of anatomy and may aid in avoiding or in recognizing injury to the thoracic duct when surgery is performed in the neck or thoracic inlet.

The second-quarter students of the years 1950 through 1953 and the assistants and instructors in the Division of Anatomy of the University of Tennessee College of Medicine assisted in the collection and study of this material.

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Relapsing Pancreatitis Secondary to Choledocholithiasis

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The early report by Darling,[8] followed by the extensive studies of Gambill, Comfort, and Baggenstoss,* has, in the past decade, stimulated an increasing interest in the problem of relapsing pancreatitis, an interest necessitated by the inherent difficulties in treatment. Several of the earlier reports indicated that relapsing pancreatitis, in contradistinction to simple acute pancreatitis, was not characteristically associated with cholelithiasis. This experience led to the hypothesis that relapsing pancreatitis might be a primary disease of the pancreas, with biliary concretions playing a rather unimportant role in etiology. More recent studies of a large series of patients reveal that the incidence of cholelithiasis is essentially the same in relapsing pancreatitis as in simple acute pancreatitis.[18] Of real importance is the observation that the results of treatment are distinctly better in those patients with biliary-tract disease than in those without. Most authors advocate thorough exploration of the biliary tree with common-duct exploration when cholelithiasis is present, but no report has indicated that the presence of common-duct stones has any greater significance than the presence of stones elsewhere in the biliary tree.

Whereas much of the present-day thought concerning the etiology of acute pancreatitis stems from the autopsy report by Opie, who found a common-duct stone in a patient dying with acute pancreatitis, the experience accumulated since that time demonstrates rather conclusively that mechanical obstruction of the ampulla of Vater by stones occurs in a relatively small percentage of patients with pancreatitis. Nevertheless, if either the "common-channel theory" or the theory that pancreatitis results from simple obstruction of the pancreatic duct is tenable, it appears that common-duct stones may be a definite etiological factor when present. Since obstruction resulting from biliary calculi is characteristically intermittent, one might anticipate recurrent attacks of pancreatitis until such stones are removed, an hypothesis which, in a limited experience, has been borne out. The purpose of this paper is to focus attention on the syndrome of recurrent pancreatitis secondary to choledocholithiasis.

Material

Approximately 200 patients with acute pancreatitis have been treated at the Jefferson Davis and Veterans Administration Hospitals since 1949. Although follow-up studies are not complete, at least 40% of these patients have had more than one attack. In this group of patients, four repeatedly had classical attacks of acute pancreatitis until a common-duct stone was identified and removed. None of these patients was alcoholic, and only one patient, on one admission, had symptoms suggestive of partial obstruction of the common duct. Since the point of interest lies in the recurrent nature of the acute illness and since the admission syndrome was not different from acute pancreatitis of other forms, the case histories are presented only in outline form (Tables 1, 2, 3, and 4). In these institutions the normal range for the serum amylase concentration is 15-50 units per 100 ml.

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* References 5 and 13.

TABLE 1.—*Relapsing Pancreatitis (Sixty-Seven-Year-Old White Man); Choledocholithiasis Following Cholecystectomy*

1946		1953 November
Cholelithiasis Cholecystectomy	Eight attacks of acute upper abdominal pain	Acute pancreatitis Serum amylase, 208 units

1953 December	1956 June
Acute pancreatitis Serum amylase, 232 units Laparotomy—acute pancreatitis with fat necrosis Choledochostomy—choledocholithiasis	Asymptomatic

TABLE 2.—*Relapsing Pancreatitis (Twenty-Year-Old Latin American Woman); Cholelithiasis and Choledocholithiasis*

1951	1952	1953 November
Acute pancreatitis Serum amylase, 106 units	Acute pancreatitis Serum amylase, 138 units	Acute pancreatitis Serum amylase, 158 units

1953 December	1956 June
Acute pancreatitis Serum amylase, 6 units Laparotomy—acute pancreatitis with widespread fat necrosis Cholecystectomy—gallstones Choledochostomy—common-duct stones	Asymptomatic

TABLE 3.—*Relapsing Pancreatitis (Fifty-One-Year-Old White Woman); Cholelithiasis and Choledocholithiasis*

1945	1951	1951-1953
Acute pancreatitis Cholelithiasis Exploratory laparotomy—widespread fat necrosis	Acute pancreatitis Serum amylase, 316 units	Numerous attacks of epigastric pain

1953 August	1956 June
Acute pancreatitis Serum amylase, 5 units Laparotomy—acute pancreatitis with widespread fat necrosis Cholecystectomy—gallstones Choledochostomy—tiny gallstone	Asymptomatic

Treatment and Results

Each patient was treated by cholecystectomy and choledochotomy. There were no postoperative complications. Three of the patients have been followed for 24-36 months, and one for 18 months. All have remained asymptomatic.

Comment

Many patients with common-duct stones are found to have a thickened head of the pancreas, which, if biopsied, will show microscopic changes compatible with a diagnosis of pancreatitis. It is generally agreed that these small areas of pancreatitis are of

TABLE 4.—*Relapsing Pancreatitis (Thirty-One-Year-Old White Man); Cholelithiasis and Choledocholithiasis*

1954 October	1954 November
Acute pancreatitis Serum amylase, 105 units	Acute pancreatitis Serum amylase, 108 units
1954 December	1956 June
Acute pancreatitis Serum amylase, 147 units Laparotomy—acute pancreatitis with fat necrosis Cholecystectomy—gallstones Choledochostomy—common-duct stones with one impacted in ampulla of vater	Asymptomatic

doubtful clinical significance and patients such as these are not included in this discussion. Rather, this report is concerned with those patients who have clinical and pathological findings which lead to a definite and primary diagnosis of acute pancreatitis, with supporting evidence of an elevation in the serum amylase concentration.

A review of the English literature resulted in the collection of 635 patients with relapsing pancreatitis in whom the biliary tree had been at least partially investigated by roentgenographic, operative, or postmortem studies, not including the patients reported herein (Table 5). In none of these reports were patients with common-duct stones analyzed as a separate group, but in several instances additional information was gained through correspondence with the author.

There were 230 patients (36%) with cholelithiasis, and 52 had common-duct

TABLE 5.—*Collected Cases of Relapsing Pancreatitis: The Incidence of Associated Biliary Calculi*

Author	Number of Patients		
	Total*	Number with Gallstones	Number with Common-Duct Stones
Barclay [1]	2	1	0
Blackburn [2]	15	4	2
Bowers [3]	5	1	0
Cogswell [4]	5	3	0
Comfort [5]	29	0	0
Comfort [6]	5	0	0
Connolly [7]	2	0	0
Darling [8]	1	0	0
De Takats [9]	4	1	0
Doubilet [10]	5	1	1
Doubilet [11]	21	8	1
Edmondson [12]	62	12	2
Gambill [13]	27	15	1
Horton [14]	8	2	0
Hurwitz [15]	3	1	0
Hyman [16]	5	0	0
Jones [17]	5	0	0
Klatskin [18]	1	0	0
Maimon [20]	20	3	0
Major [21]	23	19	2
Marx [22]	1	0	0
McCleery [23]	11	2	0
McLaughlin [24]	1	0	0
Nothman [26]	2	0	0
Poth [28]	12	3	0
Priestley [27]	100	51	13
Probstein [29]	50	0	0
Rack [29]	5	0	0
Raker [30]	74	56	18
Richman [31]	1	0	0
Rousselot [32]	5	0	0
Selesnick [33]	6	0	0
Starkloff [34]	119	47	12
Total	635	230 (36%)	52 (8%)

*Several of the papers were abstracted to include only patients with recurrent attacks.

TABLE 6.—*Relapsing Pancreatitis Secondary to Choledocholithiasis*
Patients Followed Eighteen Months or More After Treatment

Author	Number of Patients	Results of Treatment		
		Excellent	Improved	Poor
Raker[20]	16	15	--	1
Blackburn[2]	1	1	--	--
Priestley[27]	12	7	4	1
Current Series	4	4	--	--
Total	33	27	4	2

stones. Thus, of the 635 patients, 8% had common-duct stones identified, whereas of the 230 patients with gallstones 23% had a stone in the common duct.

We were able to obtain information concerning patients with common-duct stones followed 18 or more months after treatment in only 29 of these patients. The inclusion of our own patients makes a total of 33 in which such information is available. Twenty-seven (82%) have had complete relief of symptoms, four (12%) have had partial relief, and two (6%) have failed to improve. Ninety-four per cent, therefore, have benefited from surgery (Table 6).

The number of patients followed is too small to be significant statistically, and, therefore, any conclusions drawn must be tentative. However, if these data represent an accurate sampling, the results obtained are superior to those reported after the treatment of patients without common-duct stones.

Summary

A common-duct stone may be a definite etiological factor in producing recurrent attacks of pancreatitis. Removal of such calculi has been associated with good clinical results in our experience, as well as in a series collected from the literature. When biliary calculi are present in association with pancreatitis, a thorough exploration of the common duct is indicated at an elective period.

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Outbreak of Postoperative Micrococcal Pneumonia

A Clinical Analysis with Bacteriological Data

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"Miracle drugs" and a "humanity free of infectious diseases" owing to their use are catch phrases now relegated to the recent past. In the last 10 years there has been reported a rising percentage of bacterial isolates from clinical sources, resistant to one or more antibiotics formerly effective in eradicating them. These reports have come from several European countries and from all sections of the United States. Micrococcus pyogenes, foremost, by far, of the microorganisms displaying increased resistance, is a familiar enemy, with which many recent publications have dealt. No attempt will be made to review those numerous publications here, a considerable task which has been well done recently by McCoy.[1] The addition of a new publication to an already voluminous literature on the subject requires some justification. This is supplied by the fact that the sudden outbreak of staphylcoccal pneumonia, terminating fatally in some instances, at our hospital was attributable to a strain of hemolytic coagulase-negative drug-resistant M. pyogenes var. aureus as well as coagulase-positive strains.

Early evidence of an increased incidence of antibiotic-resistant Micrococcus infections of postoperative wounds and in postoperative pulmonary complications appeared on daily data sheets maintained by the microbiology section of our pathology service. This is represented graphically in Tables 1 and 2.

Although these strains were, for the most part, coagulase-positive, a few strains concerned in the pneumonic episodes were coagulase-negative (Table 2), and such isolates were labeled the "hospital strain." These organisms were serious enough as infective agents in operative wounds, but they became dangerous, rapidly lethal agents in the respiratory tree of patients having recently undergone serious abdominal or thoracic surgery.

Clinical Analysis

Micro-organisms are almost always present in the air and on the skin, despite strict aseptic precautions. It is most probable that all wounds at the operating table are potentially infected.[2]

For several months, M. pyogenes was isolated occasionally from postoperative or other traumatic wounds or from the nasopharynx of febrile patients. Its initial infrequency led to a false sense of security, although its potentialities have been often emphasized in the literature since the advent of penicillin.[3] Only in retrospect did isolation of a drug-resistant strain of this organism from increasing numbers of patients assume significance. In a matter of two weeks, a small epidemic of micrococcal pneumonias had occurred among postoperative patients. Four of these cases are briefly presented, and the clinical aspects and drug therapy are discussed.

CASE 1.—A 51-year-old white man had a hiatus hernia repaired by the thoracoabdominal approach on July 19, 1954. Because of a sudden rise in temperature, penicillin and streptomycin therapy was

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TABLE 1.—*All Micrococcal Isolates Resistant to the Tetracyclines, Streptomycin, Penicillin, Polymixin, and Sulfisoxazole*

Month	Year	Number	Coagulase	
			Positive	Negative
July	1953	2	2	0
August		0	0	0
September		1	1	0
October		1	1	0
November		0	0	0
December		1	0	1
January	1954	0	0	0
February		2	2	0
March		3	2	1
April		6	5	1
May		6	6	0
June		10	9	1
July		2	0	2
August		15	6	9
September		8	7	1
October		5	4	1
November		6	2	4
Totals		68	47	21

started three days after the operation. A serous fluid drained from the abdominal wound for five days following the surgical procedure. Complete dehiscence of the wound occurred, and a secondary closure was necessary. Five grams daily of sulfadiazine sodium was started after the surgery. Despite this therapy, the temperature remained elevated, and chest examination revealed the presence of pneumonia. Two days after the second surgical intervention the patient died. The organism isolated from lung aspirate collected at autopsy was a Micrococcus resistant to penicillin, sulfonamides, streptomycin, and the tetracycline compounds. Postmortem examination showed a massive micrococcal pneumonia.

CASE 2.—A 69-year-old white man was admitted to this hospital suffering from malnutrition and bowel obstruction on June 28, 1954. An exploratory laparotomy was done on July 7, 1954, and on July 27, 1954, a cecostomy was carried out. This patient died on July 31, 1954, and postmortem examination established septicemia, confluent bronchopneumonia, and acute and chronic pyelonephritis as causes of death. A pathogenic strain of M. pyogenes var. aureus was present in large numbers in fluid aspirated from lungs after death. This organism was resistant to streptomycin, penicillin, and the tetracyclines, all of which had been used during his operative course.

CASE 3.—A 61-year-old white man had a total gastrectomy and splenectomy for gastric adenocarcinoma and a gastric leiomyoma. Preoperatively oxytetracycline and chlortetracycline were given because of a respiratory infection. Postoperatively penicillin and streptomycin were administered for 12 days. On the 28th postoperative day, diarrhea and fever (temperature of 101 F) developed. Penicillin, streptomycin, and chlortetracycline were given. Despite this antibiotic therapy the patient died on the 37th postoperative day. Large numbers of a pathogenic M. pyogenes strain resistant to the commonly used antibiotics, except for bacitracin, chloramphenicol, and erythromycin, were isolated from lung aspirate collected at autopsy. The postmortem findings were of a massive micrococcal pneumonia and an early peritonitis.

TABLE 2.—*Antibiotic-Resistant Micrococci Isolated from Sputa, Lung Aspirates, or Pharyngeal Swabs*

Month	Year	Number	Coagulase	
			Positive	Negative
July	1953	1	1	0
August		0	0	0
September		0	0	0
October		0	0	0
November		0	0	0
December		0	0	0
January	1954	0	0	0
February		0	0	0
March		1	1	0
April		0	0	0
May		1	1	0
June		0	0	0
July		2	0	2
August		13	4	9
September		4	3	1
October		2	1	1
November		4	0	4
Totals		28	11	17

CASE 4.—A 55-year-old obese white man had a transurethral prostatectomy on June 28, 1954, to relieve prostatic hypertrophy and a subtotal gastrectomy on July 22, 1954, for benign gastric ulcer. Following this second surgical procedure penicillin and streptomycin were used postoperatively for seven days. Chlortetracycline therapy was started on the 13th postoperative day because of early signs of pneumonia. A lung abscess developed, and a strain of M. pyogenes which was sensitive only to erythromycin, chloramphenicol, and bacitracin was isolated from the sputum. Erythromycin, 200 mg. q. i. d., was given for five days, and then 400 mg. q. i. d. were given, with 200 mg. q. i. d. of chloramphenicol. The empyema cavity was drained, and erythromycin irrigations were started on the 27th postoperative day. Erythromycin and chloramphenicol therapy was continued from the 15th postoperative day until the 29th postoperative day, when the cultures of sputum were negative for the pathogenic Micrococcus. During this period intravenous erythromycin was given for five days, 500 mg. a day. Both antibiotics were again started on the 39th postoperative day and continued for 15 days, when cultures of the drainage from a large subcostal wound yielded M. pyogenes. Erythromycin irrigations of this abdominal wound were also done. This patient was discharged asymptomatic on the 74th postoperative day.

Bacteriological Analysis

It was obvious that an epidemiological investigation was necessary to reduce or eliminate this dangerous threat. The investigation undertaken consisted of the following steps: (1) seeking out carriers of these potentially lethal organisms among the personnel most intimately related to the surgical service (all physicians, nurses, attendants); (2) doing air cultures of the operating and recovery rooms and of the surgical wards; (3) culturing the different implements used in the administration of anesthetics. In addition, every patient who had had a culture report of M. pyogenes in the past year was investigated thoroughly. The cases were individually reviewed as to the surgeon, assistants, scrub nurses, assigned wards and rooms, and the procedure carried out. No consistency was observed except that all the isolates were from patients on the surgical service. All bacteriological cultures for the past year were reviewed. The clinical materials cultured were chiefly sputum, nasopharyngeal swabs, wound exudates, urine, feces, and blood. A total of 7693 specimens had been cultured, and of the 2098 yielding growth of a pathogenic organism, 173 were positive for M. pyogenes.

Nasal and throat swabs of the surgical service personnel were cultured on blood agar plates. Swabs of pieces of equipment used in administering anesthesia were cultured in trypticase soy broth enriched with yeast extract. On two different days opened blood agar plates were exposed for one-half hour in the operating room and recovery room. The microflora of the air in the surgical wards were also investigated by the same method. All tubes and plates were read after 24 hours' incubation at 37 C. They were then reincubated for another 24 hours at the same temperature and inspected again. No significant difference was observed after the added period of incubation. There were 98 cultures of personnel (49 persons), 18 cultures of ward air, and 18 cultures of equipment, for a total of 134 cultures.

On the basis of coagulase activity and sensitivity pattern, a few colonies of the "hospital strain" were isolated from two surgical wards, each on a different floor. Interestingly enough, the "hospital strain" (a resistant coagulase-negative M. pyogenes var. aureus) was isolated in large numbers from the nares of the night nurse on duty in the recovery room. No significant micrococci were isolated from the other personnel or materials studied.

The work schedule of the recovery room night nurse for the past eight months was reviewed. She had nursed each of the major cases for a period of at least eight hours. The incidence of micrococcal pneumonia quickly subsided when this nurse was removed from patient contact. Attempts to trace her patient exposure at previous places of employment met with failure.

Comment

Our 2% carrier rate in hospital personnel is decidedly lower than rate reports in the

literature.[4] Roundtree[3] reported a 32% carrier rate among the 200 hospital personnel he studied. Howe[5] gave a 99.2% carrier rate, but he included skin cultures. The wide variance can be attributed to the difference in criteria among the investigators in establishing a person as a carrier. In this study those persons from whom moderate to large numbers of pathogenic micrococci were isolated by nasal and/or pharyngeal swabs were considered to be carriers.

Circumstantial evidence pinpointed the only carrier detected as the probable focus of our micrococcal epidemic. Because of the urgency of the situation, the epidemiology was not worked out as thoroughly as it might have been. Phage typing of the strains isolated would have added to our knowledge and to a clearer definition of the problem.

Although the standard criterion of pathogenicity of micrococcal isolates among hospital laboratories is the positive coagulase test, other factors must also be considered. The accuracy of the coagulase test may be questionable, e. g., because of faulty plasma. Gram-stained smears of the freshly collected clinical material are primary aids in determining the significance of micrococcal isolates. Whatever the results of the coagulase test, a properly collected clinical specimen showing on smear and yielding in culture moderate to large numbers of micrococci must be given serious consideration by the physician. It has been our experience that organisms found to be coagulase-negative have often been highly drug-resistant. Coagulase-negative strains are usually considered avirulent or of a low grade of virulence, but if they possess a resistant antibiotic spectrum these may become a serious menace to patients weakened by operative procedures or by disease.

From each of the cases reported, strains of M. pyogenes were isolated which were resistant to penicillin, streptomycin, tetracycline, oxytetracycline, chlortetracycline, sulfisoxazole, and polymixin and sensitive to erythromycin, chloramphenicol, and bacitracin. Occasionally strains showed a slight sensitivity to polymixin. In our laboratory 42% of the micrococcal strains isolated were resistant to penicillin. This is only slightly lower than 50% to 75% reported by others.* Purdie[7] reported 11,509 wound swabs, with 42% having pathogenic Staphylococcus, and 81% of these were resistant to the usual antibiotics. The findings of Lepper and co-workers[8] are of interest and of considerable significance. For a period of five months, they discontinued the use of all penicillin and used only erythromycin and tetracycline in treating patients. The percentage of staphylococci strains isolated which were resistant to penicillin dropped from 50% to 32%. The percentage of isolates resistant to erythromycin climbed from 0% to 64%, and that of strains resistant to chlortetracycline, from 35% to 60%. They then discontinued erythromycin and used only penicillin and a tetracycline. The percentage of strains resistant to erythromycin dropped from 70% to 28%; those resistant to chlortetracycline, from 80% to 58%. On the other hand, strains resistant to penicillin increased from 35% to 83%. Their findings indicate a direct relationship between the usage of an antibiotic and an increase in strains of bacteria resistant to that antibiotic.

Diarrhea was not recognized as a prominent symptom in any of our cases. It was a transient problem in only two cases. Unfortunately, the feces of all our cases were not cultured for Micrococcus at that time. The literature seems to be most concerned with the problem of staphylococcal enteritis in antibiotic-treated patients. This has not been a problem at this hospital. That antibiotic therapy, particularly penicillin, streptomycin, chlortetracycline, and oxytetracycline, has been definitely shown to predispose to overgrowth of resistant strains of M. pyogenes has been well substantiated. An interesting finding is that of Poth,[9] who routinely cultured the stools of patients with poliomyelitis being investigatively

* References 4-6.

treated with chlortetracycline. He showed that nearly all grew out M. pyogenes. Dearing and Heilman[10] report 7 deaths among 44 patients, most of whom received chlortetracyclin or oxytetracycline for "preoperative bowel sterilization."

Of interest in one of the cases presented (Case 4) was the tolerance by the patient of intrathoracic irrigation with erythromycin.† Subsequently, a similar strength solution has been used for intrathoracic and operative wound irrigations, with like tolerance and rapid disappearance of M. pyogenes. This finding is in line with encouraging reports of good results with erythromycin by Terplan,[11] Kirby, Forland, and Maple,[12] and Herrell, Nichols, and Martin.[13]

Summary

Epidemiological investigation of an outbreak of micrococcal pneumonia is outlined. The detection of the probable focus of infection is discussed. Four cases are presented, in two of which death resulted from postoperative micrococcal pneumonia and in one of which it was a major contributing factor to the fatal termination. The importance of considering other factors in addition to the coagulase activity in evaluating the true importance of micrococcal isolates from clinical material is emphasized.

Addendum

Since this manuscript was written, an increasing incidence of antibiotic-resistant pathogenic micrococci in surgical wounds occurring early in 1956 was quickly halted. Two "effective" nasal carriers of this strain were discovered among the personnel most intimately related to surgical patients. The elimination of the organism from these persons coincided with the complete disappearance of this strain from surgical wounds.

† Erythromycin (Ilotycin) supplied through the courtesy of Eli Lilly & Company.

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Intra-Abdominal Injury from Safety Belt in Auto Accident

Report of a Case

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The epidemic number of automobile crash injuries and deaths, despite great efforts to prevent accidents, has stimulated supplementary methods to reduce injuries under crash conditions. The simplest form of crashproofing is the lap or safety belt. We are reporting a case of intra-abdominal injury caused apparently by the snubbing action of a safety belt worn during a forward type of two vehicle collision.

Report of Case

In January, 1956, a 210 lb. 34-year-old trooper, wearing his safety belt, collided with a truck which had turned suddenly into his own lane of travel. Approximate speeds of the vehicles were 10-15 mph for the truck and 40-50 mph for the automobile (1955 Ford). Damage to the car was about $300, but it was unknown in regard to the truck (latter driver not hurt). The trooper driver escaped all external injury and went about his business for about an hour, after which time he experienced lower abdominal pain, tenderness, moderate distention, and some abdominal muscle spasm (but no rigidity, in the hospital to which he was admitted shortly after onset of symptoms). Scout films of the abdomen and the entire spine were negative. All other laboratory and clinical findings were negative. Symptoms subsided considerably (although it was suspected that he had had some kind of a contusive or inertial type of intra-abdominal injury—most likely mesenteric) and he was discharged eight days after admission.

Thereafter, he continued to have recurrent bouts of discomfort which suggested some type of partial intestinal obstruction, but he continued on duty. On April, 1956, after a complete gastrointestinal, gall bladder, and abdominal scout film series, a diagnosis of adhesions of the terminal ileum was made. One of us (W. B. R.) recommended an exploratory operation. This was set for May 19, 1956, but on May 15, 1956, the man developed acute abdominal pain which was thought to be due to an appendicitis. The abdomen was opened on the following morning through a right rectus incision (W. B. R., surgeon).

Figure 1 shows the single large and firm adhesion of the terminal ileum to the right brim of the pelvis. The affected knuckle of intestine was sharply kinked at this point; which undoubtedly was the cause of the man's abdominal discomfort and recurrent episodes of partial intestinal obstruction. Figure 2 shows the raw mesenteric surface of the mesentery after it had been freed from the brim of the pelvis. Other findings, not relevant to the patient's complaints, included a mildly injected appendix (removed) and a non-inflammed Meckel's diverticulum (also removed). Closure done without drainage. Immediate response to operation, excellent. Healing was per primam. Man has been symptom-free ever since operation.

Fig. 1.—Operating room photograph of firm adhesions of the terminal ileum to the brim of the right pelvis (tip of hemostat points to adherent knuckle of intestine).

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Fig. 2.—Raw surface area of the mesentery which had been adherent to the brim of the pelvis.

Comment

The postoperative diagnosis, in respect to the adhesion, was that it had been due to the snubbing action of the safety belt during the man's sudden deceleration at the time of the accident. Two elements of the crash impact deserve further mention. First, the accident happened shortly after the subject had eaten a hearty meal. Second, he braked very hard just before the vehicular impact (believed later on that this action hurt him more than did the second jolt).

In our opinion the primary injury could have been caused either by contusion through pressure from the belt or the belt buckle, or inertial localized hemorrhage and subsequent inflammatory reaction of the mesenteric peritoneum. The first explanation seems more likely.

It is conceivable that more serious types of intra-abdominal injury may occur from safety belts in auto crashes, i. e., ruptured urinary bladder, rupture of distended knuckles of intestine, ruptured aorta, and many other possibilities. These are possibilities to be kept in mind by physicians responsible for the care of vehicle crash victims.

Opinions.—The relatively minor injury received by the subject in a moderately severe crash is attributed to the effectiveness of the safety belt which he had on at the time of the impact. The hard braking action (about 1 g) by the subject just prior to impact undoubtedly served to decrease the forces acting on his own and the other vehicle; thus also enhancing his chances for survival in an accident which could have been fatal. The snubbing action of the subject's safety belt did cause enough intra-abdominal damage to result in an adhesion of the terminal ileum to the brim of the pelvis which was gross enough to have caused recurrent attacks of partial intestinal obstruction.

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Epigastric Hernia

Results Obtained by Surgery

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Epigastric hernia, small and insignificant as it may appear to some of the professional public, nevertheless is a condition for which surgical therapy is employed. The indications for operation, technical aspects, complications, and results are dwarfed by these same considerations in what may be relatively larger problems in the more popular inguinal, femoral, umbilical, and incisional herniations.

A conscientious attempt to perfect the handling of these hernias is met with a lack of written reports concerning particularly the need for the operation and the results, in terms of whether or not the operation is worth while and what can be done to improve the results, if indeed improvement is necessary. The problems for consideration are as follows: (1) When is operation indicated? (2) What type of operative procedure will yield the best results? (3) What is the postoperative morbidity and rate of recurrence?

I. Indications

Epigastric hernia is located anywhere in the linea alba between the umbilicus and the xiphoid process. These hernias appear single or multiple, are usually small, incarcerate frequently, strangulate rarely, and contain mostly properitoneal fat. Hall [7] found these hernias in 10% of Army inductees, and they are more commonly seen in men than in women. These few facts suggest that urgent need of operation must not frequently be seen.

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However, these hernias are often tender and painful to touch, to tight clothing, or during heavy physical labor. It is believed that the pain alone psychologically induces perhaps warranted "neuroses." Indeed, many of the patients worry about the nature of whatever may be causing the pain, for it is common knowledge that many dangerous diseases in important organs manifest themselves by epigastric pain. This creates the main problem for the use of surgery. When the hernia has been discovered, the first problem confronting the physician involves reasonable deduction as to whether the pain is due to the hernia or some underlying abdominal pathology, the pain of which is easily mirrored by the more cutaneous position of the sensitive properitoneal fat.[14] The initial symptoms of early peritonitis are often referred to the hernia. The inflamed and sensitive peritoneum receives little protection from the thin skin and subcutaneous covering. Also, the referred pain of early appendicitis or diverticulitis is often located in the epigastric region. Ulcer pain notably exists in the midepigastrium. Even gall bladder and pancreatitic pains may be referred to this area, and adhesions with accompanying partial intestinal obstruction may produce upper midline abdominal pain.

The question then arises, is the pain primarily due to the herniation, which is known to produce pain, particularly if incarcerated, or is the pain secondarily referred to the site of the hernia? Accurate differentiation must be established if good results are to be obtained by the herniorrhaphy. But the accomplishment of this accurate differentiation may require the keenest clinical evaluation. It can only be done with the most searching history-taking, physical examination, and judiciously se-

lected laboratory and roentgen tests. Eventually, good clinical judgment must dictate the course, because failure will obviously follow if the hernia is repaired, for instance, when peptic ulcer is the cause of the pain element for which the patient seeks relief. There will appear instances when the hernioplasty must be accompanied by abdominal exploration, but to explore every patient means poor study and planning by the surgeon who employs the larger operation unnecessarily.

In our study, although there were two instances of cholelithiasis and one instance of duodenal ulcer in association with the epigastric hernia, only one case of acute appendicitis appeared as an unsuspected pathological associated lesion. This means, it is believed, that a thorough preoperative study can eradicate the need for the abdominal exploration in the vast majority of the cases, a procedure which had been favorably recommended by many.*

Another indication for the operation is the existence of an epigastric hernia with an umbilical hernia, when the umbilical hernia is the main offending condition. If the epigastric hernia is overlooked and not repaired, then the umbilical hernioplasty may be regarded as a failure by the patient and a second operation needed, when earlier consideration of the epigastric hernia and its repair could well have solved these two disagreeable happenings.

II. Technical Aspects

The operations employed vary from a simple closure of the fascial defect,† which is probably not good, to a vertical incision with approximation of the anterior and posterior sheaths of the rectus muscles,[1] to overlapping with a two-row suture in the form of imbrication.[16] The vertical incision with overlapping procedure should prove the soundest,[17] although more suture material is required than in the other procedures.

The peritoneum is usually opened for a small distance, although many prefer to remove the properitoneal fat without incising the peritoneum. There is no sizeable sac and no high sac dissection; pursestring closure of sac cannot usually be done.

The main decision technically involves a twofold plan: Should the incision be a longitudinal or a transverse one? While the transverse incision has proved to be a highly satisfactory one in the repair of umbilical hernias if not accompanied by epigastric hernia, it is not satisfactory for the epigastric hernia because the defects are apt to be multiple, and occurrences or appearances of other hernias close to the transverse hernioplasty have frequently been observed. For example, 13 of the 79 patients demonstrated multiple epigastric herniations. Of the 6 recurrences in the 64 followed patients, 2 had transverse incisions. The transverse incision is particularly bad when other small herniations or weaknesses in the linea alba are overlooked. The vertical incision will often disclose these defects, and the fascia incision and ultimate repair cover a large and important area. Also, four of the recurrences, two of which had a transverse incision, were found when the umbilical hernia was also present. For this reason, we believe that the longitudinal fascial incision should be fairly long, much longer than seems apparent at first, and closure thus employed to prevent future herniations in and near the main repair.

Secondly, one must decide, from accurate and thorough preoperative studies, whether to explore the abdomen at the time of the hernioplasty. In the series of 79 epigastric hernioplasties under consideration for this study, intra-abdominal exploration accompanied the hernioplasties in 23 patients. Four patients demonstrated definite abdominal pathology, which certainly increased the pain sensation in the hernia. There were two instances of cholelithiasis, one instance of duodenal ulcer, and one acute appendicitis case. Nineteen of the twenty-three explored patients revealed no underlying pathology which could be responsible for the visceral symptoms referred to the region of

* References 4, 5, 8-10, and 13.

† References 2 and 12.

the hernia. Ostensibly then, 19 of these explorations were useless.

It appears, therefore, that exploration will rarely be indicated if the preoperative diagnostic tests, properly and judiciously used, are negative.

It appears that the type of suture material—silk, cotton, absorbable, or wire—exerted no definite influence on the role of recurrence, although the nonabsorbable sutures created more difficulty with the handling of the wound if infection ensued. The type of operative procedure and the selection of suture material are probably not as important in the achievement of good results as the skill of the surgeon. Conversely, it does not hold that reliance upon what is referred to as best technique and procedure will achieve good results unless these same techniques are performed skillfully.

III. Results

Sixty-four of seventy-nine patients were observed as follows: fifty by the author's personal examination; eleven by the examination of reliable physicians, and three by questionnaire letter. The average postoperation time was four and one-half years, and the time period varied from two years to nine years.

Pain, infections, and recurrence rate proved to be the significant points from the study. Obviously, if there is no death, no infection, no pain, and no recurrence, then the operative results would achieve a point of perfection. The degree of deviation from perfection, then, would indicate the feasibility of the use of hernioplasty for the condition. There was no death.

Pain.—There were 63 instances of preoperative pain in the 79 patients. Forty are classified as local and twenty-three as deep epigastric pain. Practically, however, the postoperative presence or absence of pain is the significant consideration,[3] local or otherwise. Of the 64 followed patients, 12 complained of postoperative pain, but in 6 of these patients the pain can be attributed to the recurrence. Therefore, only six experienced pain when operation successfully stood the test for a proper number of follow-up years. From this standpoint, the operation can be considered successful.

Infection.—There were four instances of infected wounds, an infection rate of 5% (Table 1). The infection rate of all types of inguinal hernia at Kennedy Hospital is 0.8%. It appears from this experience that one may expect a higher rate of infection in these cases than in other abdominal hernias.

The procedure requires minimal manipulation, a fact that favors less incidence of infection, but the location in the midline is attended with less vascularity, and very probably more foreign body in the form of suture material is used to obtain what the operator may believe to be necessary to prevent recurrence. This statement is probably a true one, because wound healing appears to be poorer in upper midline incisions than in other abdominal incisions, and suture-line stress is greater. However, the infection has not appeared to be a factor in permitting recurrence as one sees in infected inguinal, incisional, umbilical, or femoral hernias.

Recurrence.—There were 6 recurrences

TABLE 1.—*Wound Infections*

Patient	Abdomen Explored	Associated Intra-Abdominal Pathology	Type Repair	Suture Material	Recurrence
1	Yes	No	Vertical side-to-side	Silk	No
2	Yes	Appendicitis	Transverse side-to-side	Gut	Unknown
3	No	No	Vertical side-to-side	Gut	Unknown
4	No	No	Vertical overlap	Silk	No

TABLE 2.—*Recurrences of Epigastric Hernias*

Patient	Combined with Umbilical Hernia	Abdomen Explored	Associated Intra-Abdominal Pathology	Type Repair	Suture Material
1	Yes	No	No	Transverse imbrication	Wire
2	Yes	No	Pneumoperitoneum	Transverse side-to-side	Silk
3	Yes	Yes	Cholecystectomy	Vertical imbrication	Wire
4	Yes	No	No	Vertical side-to-side	
5	No	No	No	Vertical imbrication	Silk
6	No	Yes	No	Vertical side-to-side	Silk

in the 64 followed cases, a recurrence rate of 9.4% (Table 2). This appears to be higher than the recurrence rate of indirect inguinal hernia (approximately 2%) or direct inguinal hernia (approximately 5%), but less than the recurrence rate of repair for sliding hernia (12%).[15] The figures mostly designate approximate rates of recurrence at Kennedy Hospital. The recurrence rates for epigastric and sliding hernia have been accurately determined in this clinic. One point is clear. Recurrence occurs when the operator overlooks a weakness or a second or several defects in the linea alba and repairs only the large herniation. An analysis of these recurrences reveals that three (half) were probably due to the development of new epigastric hernias rather than recurrence in the actually operated one. It is believed proper to classify this as a recurrence, because the weakness probably existed at the first operation and was not recognized by the operator, or a long enough vertical incision was not used to insure no future appearances of neighboring herniations. In other words, cure was not established by the first operation.

A second point involves an increase in rate when umbilical hernia accompanies the epigastric hernia, especially if transverse incision is employed. Four out of six recurrences occurred in patients who had umbilical hernia associated with the epigastric hernia. Of the nine combined followed cases, i. e., epigastric plus umbilical hernia, four experienced recurrences, and of these four, two had the transverse incision. This point seems significant and suggests the abandonment of the transverse incision in favor of a vertical incision, when these hernias coexist. Also, it suggests extreme care in the technical handling of these patients. Infection and suture material did not influence the recurrence rate materially.

The literature contains very limited information about recurrence rate in epigastric hernia. The rate is probably higher than surgeons believe. Most authors conclude that the recurrence rate is the highest of all primary hernias.‡

Summary

Findings from the follow-up study of 79 patients previously operated for the cure of epigastric hernia are presented.

Mortality and morbidity are not great problems, although the infection rate has been higher than in other hernioplasties.

Exploratory laparotomy should not frequently accompany the hernioplasty if the proper preoperative studies are made and carefully weighed for clinical evaluation.

The study suggests that the vertical incision is probably sounder than the transverse incision, especially if umbilical hernia is also present.

The relief of pain has been more satisfactorily accomplished than the prestudy opinion indicated.

‡ References 6 and 17.

The recurrence rate proved to be 9.4%. Herniations near the site of the original operation are included as recurrences in this report.

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Jejunal Obstruction as a Complication of Acute Hemorrhagic Pancreatitis

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The pathogenesis of the various sequelae of acute hemorrhagic pancreatitis generally is more understandable than that of the parent condition. Up to the present time, efforts both to fathom the cause and to devise a consistently satisfactory treatment for pancreatitis have been relatively ineffectual.

The majority of the complications of acute pancreatitis are produced by the intense inflammatory process which occurs in the area of the pancreas. Among these complications must be included pseudocyst of the pancreas,[8] pancreatic fistula, subdiaphragmatic and intra-abdominal abscess, biliary tract obstruction with jaundice,[2] splenic infarction,[3] and pleural effusion. Secondary metabolic disorders, both diabetes[10] and alterations in calcium metabolism,[11] have been reported.

Although intestinal obstruction has been recorded in a few instances, this complication has largely involved the large intestine in the region of the splenic flexure.* For this reason, it has seemed desirable to report an unusual case of high jejunal obstruction of the closed-loop type which occurred approximately six weeks after the onset of an episode of acute hemorrhagic pancreatitis. This obstruction resulted from the involvement of two loops of proximal jejunum in a large inflammatory mass in the area of the distal body and tail of the pancreas.

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* References 4-6 and 9.

Report of a Case

The patient, a 39-year-old white man, was admitted to the hospital on Dec. 3, 1955, because of severe abdominal pain of eight hours' duration. The pain was steady and of sudden onset. It began in the epigastrium and shortly thereafter became generalized. He had vomited once prior to admission.

He had noticed some vague abdominal distress for approximately two months prior to admission. He had been discharged from the Navy in 1945, because of "intestinal neurosis." The remainder of his past history was essentially negative.

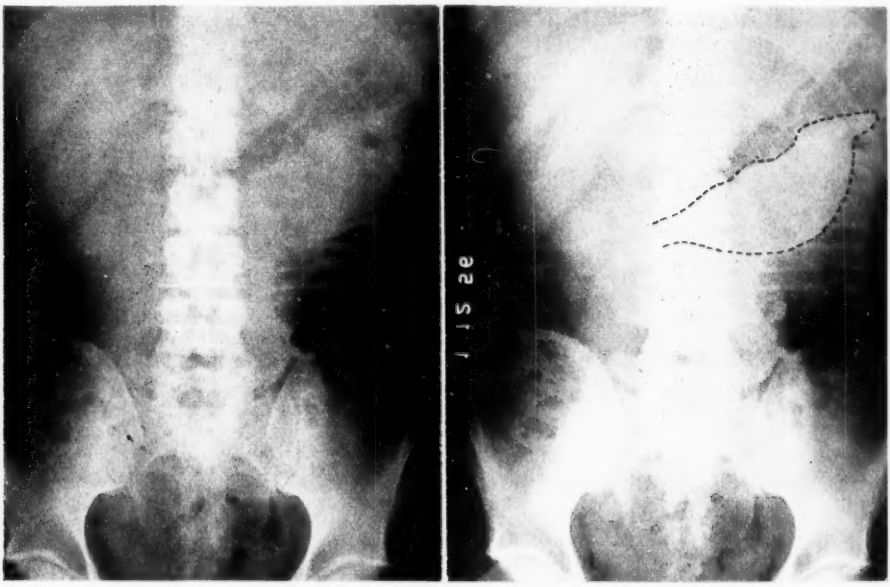
On physical examination the patient was found to be acutely ill. His abdomen was board-like, with generalized tenderness. There was slight abdominal distention. There were no audible bowel sounds. The findings on urine examination were within normal limits. The hemoglobin was 17 gm. per 100 cc. and the red blood cell count, 5,100,000. The white blood cell count was 16,800, with 86% polynuclear leucocytes. Upright roentgenograms showed no evidence of air under the diaphragm.

Because of the strong suspicion that the patient was suffering from a perforated peptic ulcer, he was taken to the operating room shortly after admission to the hospital. The peritoneal cavity was entered by means of an upper right rectus muscle retracting incision. No free air and only a relatively small amount of free fluid was encountered in the peritoneal cavity. There was no evidence of a perforated gastric or duodenal ulcer. However, several areas of fat necrosis were identified in the region adjacent to the pancreas. The opening of lesser peritoneal cavity at the foramen of Winslow seemed to be occluded. This was opened by blunt dissection, and a large amount of bloody fluid escaped as though under considerable pressure. It was now quite apparent that the patient had acute hemorrhagic pancreatitis. A long Penrose drain was inserted into the lesser peritoneal cavity through the recently opened foramen of Winslow in order to insure adequate drainage of this cavity and diminish the likelihood that a pseudocyst of the pancreas might develop. The drain was brought out through a stab wound in the right upper quadrant. The incision was closed in layers with fine nonabsorbable (silk) surgical sutures.

The serum amylase was found to be 3200 Somogyi units following operation. Gastric suction and parenteral replacement of lost fluid and electrolytes were maintained for four days. The patient also was given parenteral antibiotics and propantheline (Pro-Banthine). Although his symptomatic recovery was relatively prompt, his serum amylase levels remained moderately elevated for three weeks. He was discharged from the hospital on Dec. 31.

Seven days after his release from the hospital, symptoms of abdominal pain returned. One day prior to his readmission to the hospital, on Jan. 12, the intermittent pain became much severer and he vomited frequently. High-pitched, hyperactive bowel sounds were heard on auscultation. His hemoglobin was 16.5 gm. per 100 cc., and the red blood cell count was 5,500,000. The white blood cell count was 12,100, with 76% polymorphonuclear leucocytes. The serum amylase was 100 Somogyi units. A flat roentgenogram showed a single distended loop of small intestine in the left upper abdomen (Figure). From the configurations of the gas patterns in the stomach and the distended loop of intestine, it is possible to outline the pancreatic mass subsequently found at operation. Upright studies revealed a fluid level in the distended loop.

Shortly after admission to the hospital, he was taken to the operating room, and his peritoneal cavity was entered through an upper left rectus muscle retracting incision. A sizable amount of straw-colored fluid was encountered within the peritoneal cavity, approximately 1000 cc. Some of this fluid was saved for study and was found to have an amylase concentration of 3200 Somogyi units. A large solid inflammatory mass was found to involve the distal body and tail of the pancreas. The proximal and distal ends of a loop of proximal jejunum were firmly adherent to this mass, with their ends occluded in such a manner as to produce a closed loop type of mechanical obstruction. The obstructed loop of jejunum was freed up with some difficulty and the obstruction relieved. There was no evidence of pancreatic pseudocyst formation. The incision was closed with interrupted sutures of fine nonabsorbable (silk) surgical suture.



Flat, unretouched roentgenogram of the abdomen, showing the dilated loop of small intestine, mounted beside a retouched film in which a dotted line is used to outline the solid, inflammatory pancreatic mass discovered at operation and suggested on roentgen study.

The postoperative course was uneventful. Both propantheline and antibiotics were given. Gastric suction was maintained for several days. His serum amylase levels did not rise above 400 Somogyi units and were normal when he was discharged from the hospital, on Jan. 29. He has remained free of symptoms.

Comment

There are several interesting clinical observations to be made in this case. The sud-

den onset of symptoms in the initial episode accompanied by the silent abdomen with board-like rigidity led me to depart from my customary practice of obtaining a serum amylase level in cases of upper abdominal pain and to operate upon this patient immediately with an erroneous tentative diagnosis of perforated peptic ulcer. There was little free fluid in the peritoneal cavity. The foramen of Winslow was closed. When it was opened a large amount of bloody fluid escaped from the lesser peritoneal cavity as though under considerable pressure. Had not the foramen of Winslow been opened and a Penrose drain inserted into the lesser peritoneal cavity for drainage, a pseudocyst of the pancreas might have developed in this enclosed space. The large, solid, inflammatory mass in the distal body and tail of the pancreas was not present at the time of the first operation and presumably came into being a short time thereafter. It was to this large mass that the loops of proximal jejunum became densely adherent, producing the closed loop type of intestinal obstruction. Although the serum amylase level was within normal limits prior to the second operation, the abundant free fluid in the peritoneal cavity had an amylase level of 3200 Somogyi units. The jejunum had remained viable, and the obstruction was relieved by freeing up the involved loops of intestine. The patient has remained well. There has been no demonstrable recurrence of pancreatic inflammation or evidence of pseudocyst formation.

A case of ileal obstruction following acute hemorrhagic pancreatitis was reported by de Vidas, in 1947.[4] The obstruction was caused by peritoneal bands which were formed from organized peritoneal exudate, following acute hemorrhagic necrosis of the pancreas. Benedetti,[1] in 1920, recorded a rather unique case in which acute duodenal obstruction was produced by acute pancreatitis in an adult patient with a previously asymptomatic annular pancreas.[7] I have not encountered any reported experience with either ileal or jejunal obstruction of the type reported here as an aftermath of acute pancreatitis.

Large intestinal obstruction at the level of the splenic flexure has been reported in a few cases.† In some the obstruction was produced by an acute inflammatory mass. In others the obstruction appeared as a late complication resulting from the stenotic scarring which occurred in the wake of an old pancreatic inflammatory process.

Summary

An unusual case of high closed-loop type of jejunal obstruction occurring as a complication of acute hemorrhagic pancreatitis in a 39-year-old man is reported. The obstruction appeared six weeks after the onset of the initial episode of acute pancreatitis and was produced by the dense adherence of two loops of proximal jejunum to a large inflammatory mass which involved the distal body and tail of the pancreas. The intestine remained viable, and the obstruction was successfully managed by freeing up the affected loops of jejunum. I have been unable to discover any similar reported experience with jejunal obstruction as a sequelae of acute hemorrhagic pancreatitis.

† References 5, 6, and 9.

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Massive Resection of the Small Intestine

Report of a Case of Resection of Three Hundred Forty-Five Centimeters of Small Intestine

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Successful resection of great lengths of small intestine is relatively infrequent. There are, however, fairly numerous reports of successful cases in literature.

It seems worth while to report this case because it represents a relatively infrequent surgical opportunity and because of the small amount of small intestine remaining after the resection, 15 cm. of jejunum and 7 cm. of ileum.

Report of Case

A 48-year-old lawyer was admitted to the hospital on Oct. 30, 1950, about two hours after the onset of severe generalized abdominal pain. The patient was known to have had six attacks of rheumatic fever, starting at the age of 7 years, with the last attack occurring at the age of 37. He was known to have mitral stenosis and insufficiency and possibly an aortic lesion as well. However, there was no history of limitation of ordinary activity. He had had no attacks of dyspnea and no edema. He had had typhoid in 1910. In July of 1949, the patient had a complete occlusion of the left femoral artery in Hunter's canal. A successful embolectomy was done by the author at that time with no untoward after-effects. He had continued to carry on his work as a lawyer.

During the interval, he was quite well except for a febrile illness before admission, which lasted for three or four weeks.

At 8 p.m. on Oct. 30, 1950, abdominal pain began. He vomited and had a large loose bowel movement which apparently was dark or black in color. The vomitus consisted of all recently ingested food. He vomited two or three more times in the next hour, and following this, he was nauseated but did not vomit any more. The pain centered about the umbilicus but otherwise did not localize.

Physical examination shortly after admission revealed a thin man, acutely ill, and having rather severe abdominal pain. His weight was 107 lb. His temperature was normal. The pulse rate was 64 per minute, and the blood pressure was 140 systolic and 80 diastolic. The skin was cool and slightly moist. The heart was quite markedly enlarged, and there was a murmur which replaced systole and diastole over the precordium.

When first seen, the abdomen was flat and quite soft. It was only slightly tender throughout. Moderate peristalsis was present. The remainder of the examination was negative.

The initial blood count showed 18,400 leukocytes (95% polymorphonuclears) per cubic millimeter. The urine showed a 1+ proteinuria and a trace of sugar.

The patient became progressively more ill during the hours following his admission. The pain in his abdomen was quite severe, requiring morphine every three hours. The abdomen gradually became more tender. Muscle spasm began to appear. The abdomen remained flat, but peristalsis was absent. An enema showed light-brown-colored water in the return but no gross blood. The patient was seen by a medical consultant who recommended prophylactic digitalization but believed the heart would stand the operation fairly well.

The patient was taken to the operating room about 16 hours after admission. He was anesthesized with cyclopropane, and an endotracheal tube was passed. The general anesthesia was supplemented with local procaine infiltration and block of abdominal wall. A right-rectus-muscle-splitting incision was made with its midpoint at about the umbilicus. When the peritoneum was opened, approximately 7 to 8 oz. of thin, slightly brownish fluid was found and aspirated. Practically the entire small intestine was found to have the circulation impaired, and the bowel varied in color from gray to black. The infarcted bowel felt much thinner than normal. A musty odor was detected. A fairly sharp line of demarcation was found in the jejunum about 15 cm. from the ligament of Treitz. The line of demarcation at the lower end of the small intestine was in the ileum, about 7 cm. from the ileocecal valve. It was apparent that there had been an occlusion of the superior mesenteric artery. It was decided to resect the infarcted bowel. The bowel was divided at the points of demarcation. The diameter of the

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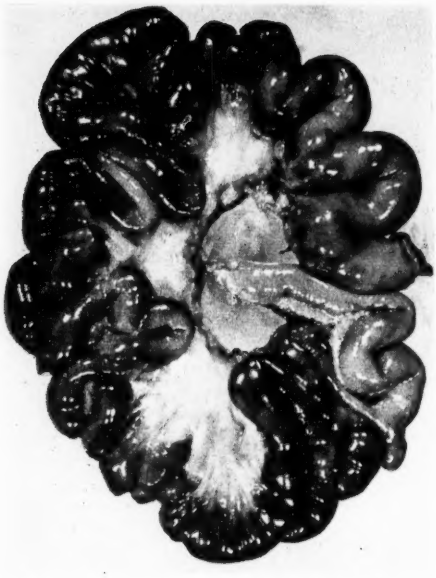

Fig. 1.—Photograph of the surgical specimen of small intestine. It measured 345 cm. in length.

jejunum was found to be twice that of the ileum, and, therefore, a side-to-side anastomosis was carried out. First, each cut end of the bowel was inverted; then, an open type of anastomosis was carried out with an outer row of interrupted nonabsorbable (silk) surgical sutures, and then a row of continuous absorbable (chromic gut) sutures. The opening in the mesentery was closed with interrupted absorbable sutures.

During the procedure, which lasted 1 hour 40 minutes, the patient was given 1000 cc. of blood. He withstood the procedure quite well.

The portion of the bowel excised is shown in Figure 1. Its length was found in the Pathology Laboratory to be 345 cm.

Postoperatively, a Levin tube was placed through the nose and into the stomach and attached to suction. The patient was given 50 mg. of heparin every four hours for three days; then he was started on bishydroxycoumarin (Dicumarol), which was continued. He was given ½ grain (30 mg.) of papaverine every four hours intravenously for four days. Four hundred thousand units of penicillin and 0.5 gm. of dihydrostreptomycin were administered intramuscularly every 12 hours for seven days. Five hundred milligrams of chlortetracyline (Aureomycin) was administered intravenously twice a day for four days.

The pulse and respiration were quite rapid for several days, but by the fifth postoperative day they had returned to within normal limits. Gastric suction was continued until the fifth postoperative day. The abdomen never became distended. By the sixth postoperative day, the patient had passed flatus and was having occasional liquid stools. Liquids were started by mouth on the fifth postoperative day. At this time the patient had no nausea. By the seventh postoperative day, the patient was placed on a liquid diet, which he tolerated well. On the ninth day, he was placed on a low-fat, low-residue, soft diet.

At this time, he was having moderately severe abdominal cramps and six to eight liquid stools a day. The cramps were worse at night. On the 20th postoperative day the liquid stools were down to four or five a day. By this time he was eating well, being given frequent feedings of small amounts of food. He was discharged on the 22d postoperative day. His blood chemistries had remained normal during his postoperative course. The operative wound healed uneventfully.

At discharge, the patient was placed on a low-fat diet with frequent feedings. He was given vitamins and iron and was continued on bishydroxycoumarin. He resumed work three months postoperatively. By the end of six months he had gained 10 lb. In November, 1951, one year postoperatively, the patient was feeling quite well. At this time his hemoglobin was 12.9 gm. per 100 cc. and his red cell count was 4,250,000 per cubic millimeter. On Oct. 18, 1951, a gastrointestinal series was done. There was evidence of hyper-

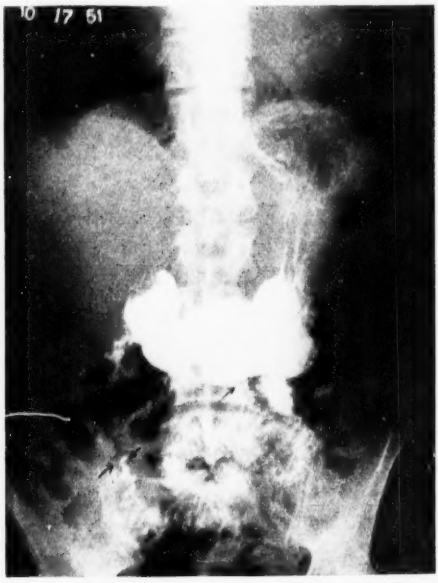

Fig. 2.—Roentgenogram of intestinal tract one year postoperatively. The remaining small intestine is shown between the upper and lower arrows.

irritability of the remaining intestinal tract. The remaining ileum and jejunum is shown in Figure 2, between the two arrows. On January, 1952, he was having only one semiliquid bowel movement a day. He had been tried on methenamine and Lipomul, (an emulsion of vegetable oils and dextrose), but these were not tolerated well. On Feb. 14, 1952, he began to have precordial discomfort and shortness of breath.

He was hospitalized on Feb. 23, 1952, because of apprehension, weakness, and dyspnea of a week's duration. His blood pressure was 125/55. The pulse was 92 and the respirations, 28 per minute. As on previous occasions, the heart was enlarged, and there were double murmurs at apex and base. The lungs were clear. The liver was not enlarged. There was no peripheral edema.

The hemoglobin on admission was 11.7 gm. per 100 cc. The urine showed a 2+ protein. The blood urea nitrogen was 10 mg. per 100 cc. The prothrombin activity was 35% of normal. The serum sodium was 135 mEq per liter; the chloride, 95; the potassium, 5.2, and the carbon-dioxide-combining power was 20 per liter.

During the six days of his hospital course, he continued to show dyspnea, which was the most prominent symptom. He was also restless and quite continuously nauseated, with occasional vomiting. He had frequent bowel movements. About 36 hours before death, on the sixth hospital day, he began to show symptoms of shock. His temperature became elevated, and there were coarse rales in the lungs.

An autopsy was done. The jejunum was found to measure 18 cm. and the ileum 10 cm. in length. The jejunoileal stoma was patent. The heart showed mitral and aortic stenosis and cardiac hypertrophy. There was a pulmonary infarct in the lower lobe of the left lung. There was passive congestion of the gastrointestinal tract and lungs and nephrosclerosis of kidneys.

Comment

The first successful extensive intestinal resection was reported in 1881, by Koeberle. He resected 205 cm. of intestine with recovery.

In 1935, Haymond reported an analysis of 257 cases of extensive intestinal resection which he had collected. He considered as extensive any case in which over 200 cm. of bowel was resected. In his article, he stated that the average length of the small intestine is 21 ft. 6 in. (6.55 m.) with a variance of from 10 to 28 ft. (304 to 862 cm.). In this series, there were 86 cases with good results. There was an average resection of 310 cm. It was considered that resection of 50% of small intestine was the upper limits of safe removal.

The greatest length of intestine successfully resected was 18 feet (5.54 m.) by von Biermer, as cited by Holman.

Berman and his co-workers showed that the removal of the upper half of the small bowel causes no more disturbances than removal of the lower half. Two-thirds of the small intestine may be removed without risk of life. There was said to be no alteration in the nutritional status when one-third of the small intestine is removed. However, if over 50% is removed, absorptive and nutritional disturbances appear.

In their studies, after extensive intestinal resection, West and Todd found carbohydrates were normally utilized. About 70% to 75% of proteins were found to be absorbed. Fats were absorbed poorly, with about 45% being lost. They also noted an excessive loss of calcium when a large amount of fat was included in the diet.

According to Bothe, the commonest findings following massive resection of the small intestine are (1) loss of weight, (2) intractable diarrhea, (3) edema, (4) anemia, (5) loss of fat and protein, (6) lowering of the blood calcium and serum protein, and (7) elongation, dilatation, and hypertrophy of the remaining bowel.

The mortality associated with extensive resection for mesenteric vascular occlusion has been reduced in recent years.

Seybold and Musgrove reported on the experience from the Mayo Clinic. They stated that Whittaker and Pemberton in 1938 reported 60 cases of mesenteric vascular occlusion encountered up to that time. Only 19 (31%) of these patients were operated on, and 16 (84%) died. All 41 patients who were not operated on died. Seybold and Musgrove reported on an additional 24 cases encountered at the Mayo Clinic from 1938 through 1948. Thirteen of these cases were operated on, and three died. This was a surgical mortality rate

of 23%, compared with one of 84% in the first period.

All authors agree that early resection of the involved intestine and mesentery is necessary for successful results in these cases. Usually a primary anastomosis is done, although occasionally an exteriorization procedure may seem to be indicated. Accessory forms of therapy are necessary, such as parenteral water and electrolytes, intestinal decompression, whole-blood transfusions, antibiotics, and anticoagulants.

Seybold and Musgrove recommended continuous gastrointestinal suction until the patient passes flatus. Drugs given orally for intestinal antisepsis were also recommended. Papaverine hydrochloride in doses of ½ grain intravenously every four hours for the first 48 hours was thought to be of some possible benefit. When the patient can tolerate a diet, it should have a low-residue, low-fat, medium-protein, and high-carbohydrate content.

Summary

A case is presented in which massive resection of the small intestine was carried out because of mesenteric vascular occlusion. The patient was left with about 15 cm. of jejunum and 7 cm. of ileum. He survived for 17 months, apparently dying of heart failure.

A few contributions to the literature of mesenteric vascular occlusion are quoted, and the treatment of this condition is discussed.

154 Waterman St. (6).

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Ventricular Fibrillation During Hypothermia

Tolerance of the Hypothermic Dog Heart to Ventricular Fibrillation

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In a previous report from this laboratory,[1] it was shown that normal dogs undergoing hypothermia tolerated varying periods of ventricular fibrillation up to two hours with defibrillation and recovery. The dogs were resuscitated by cardiac massage, during which time the temperature of the heart was increased by warm saline irrigation of the thoracic cavity, followed by electric shock applied to the heart. Since the hearts of these animals were essentially normal, and since any clinical application of accepting or inducing ventricular fibrillation for cardiac surgery would be carried out on abnormal hearts, this project was extended to determine the tolerance of the abnormal dog heart to ventricular fibrillation during hypothermia.

Methods

Adult healthy mongrel dogs weighing from 9 to 27 kg. were used. Two types of abnormal hearts were produced. The first, a cyanotic preparation, was created finally by the method of Watkins.[2] Initially, other methods of producing cyanosis, such as anastomosing the left pulmonary artery to the left auricular appendage, both end-to-side and side-to-side, and with and without partial occlusion of the right pulmonary artery, proved unsatisfactory. When the right pulmonary artery was not occluded, the flow was inadequate to keep the anastomosis patent. When the right pulmonary artery was partially occluded, the animals did not survive. The creation of an atrial septal defect with suture of part of the tricuspid valve, as described by Watkins, resulted in a preparation which was accomplished with a negligible mortality and with an arterial oxygen saturation which remained low. These defects were produced at normal body temperatures. The animals were anesthetized with pentobarbital, 30 mg/kilogram and ventilated with an automatic respirator using room air. The chest was entered via the right fourth interspace, the azygos vein was ligated, and tapes were placed about the vena cavae after the phrenic nerve was freed. After inflow occlusion, the right auricle was entered. Three or four sutures were placed in the annulus of the tricuspid valve to occlude 60% to 70% of the valve. The cavae were then released and the auricular incision clamped. The period of inflow occlusion was usually three minutes. The auricular incision was then sutured and the chest closed. The animals were returned to their cages for a minimum of three and an average of four months prior to utilization in the hypothermia experiments. These dogs received no drugs, and only dogs with unquestionably diminished arterial oxygen saturations were used in the hypothermia experiments.

The second type of defect produced was a left pulmonary artery-to-aorta fistula after the method of Potts, Smith, and Gibson.[3] The left chest was entered through the fifth intercostal space. The left pulmonary artery was mobilized and the descending aorta adjacent to it mobilized, ligating two or three pairs of intercostal vessels. The aorta was cross clamped above and below the area for anastomosis and a 4 mm. ellipse of aorta excised. The left pulmonary artery was then temporarily ligated and the anastomosis completed. Since the occlusion of the aorta was 15 minutes or less, a partial occlusion clamp was not necessary. The chest was closed and the animals returned to their cages for a minimum of seven and an average of nine months. They were placed on digitalis therapy on the first postoperative day for a period of three weeks, after which it was discontinued. Several of the animals in this group died of congestive heart failure before they could be utilized. Only dogs which had loud, harsh murmurs after seven months were selected. The precooling electrocardiograms showed left ventricular enlargement in all dogs of this group, as evidenced by increased amplitude of the R wave in all dogs and inverted T waves in many. Cardiac

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enlargement was confirmed by autopsy. During the hypothermia experiments, lung biopsy at the time of thoracotomy for defibrillation uniformly showed gross pulmonary edema (Table 1).

TABLE 1.—*Precooling Aortic Pulse Pressures and Incidence of Pulmonary Edema at Time of Ventricular Fibrillation*

	No. of Dogs	Average Pulse Pressure (Range)	Biopsy Done, No.	Pulmonary Edema
Pulmoaortic fistula				
Survivors (7 days)	6	75 (55-90)	3	2
Nonsurvivors	9	91 (50-155)	8	6
Cyanotic	12	57 (30-95)	--	--
Controls	12	46 (30-65)	--	--

A group of normal dogs was used as controls following three weeks' quarantine and observation.

Hypothermia Experiments

The animals were anesthetized with pentobarbital (30 mg/kilogram) and clipped and the trachea intubated. A catheter was placed into the aorta via the femoral artery and connected to a strain gauge. Rectal and esophageal temperatures were recorded on a Brown Potentiometer, but only rectal temperatures will be reported. Standard limb leads were applied, and a continuous three-lead electrocardiogram with aortic blood pressure was recorded on a Sanborn Polyviso. The animal was immersed in an ice bath at 4 C. The endotracheal tube was connected to a constant-volume automatic respirator utilizing room air; the animal was hyperventilated throughout the experiment. Usually, the induction dose of pentobarbital was sufficient to prevent shivering, but when it did occur, an additional 60 mg. of pentobarbital via the arterial catheter was sufficient to abolish the shivering. The animals were colled until ventricular fibrillation occurred. At this point, the respirator was turned off and the ice water removed. After 30 minutes of fibrillation the left chest was opened, the respirator turned on, and cardiac massage begun. A continuous irrigation of the thoracic cavity was carried out with saline at 40 C during the massage. A 170-volt electric shock was applied to the heart for 0.1 second after the initial massage prior to starting the irrigation. The shock was repeated each time the animal's rectal temperature rose 1 C until defibrillation occurred. In the pulmoaortic fistula group, a lung biopsy was done to determine the presence of pulmonary edema. Following successful resuscitation the chest was closed when the rectal temperature reached 30 C and the animals returned to their cages. If attempts at resuscitation were unsuccessful after rewarming the animal to 30 C, the experiment was terminated.

Results

1. *Cyanotic Group.*—Twelve dogs of the cyanotic group had arterial oxygen saturations in an unquestionably low range, and these were used in the experiments. Arterial oxygen saturations were measured at 37 C and again at 23 C in this group (Table 2). The temperature at which ventricular fibrillation occurred ranged from 15 to 24.2 C and averaged 18.8 C. The temperature at which defibrillation was accomplished ranged from 13 to 23.7 C and averaged 20.8 C. All of the animals were defibrillated. One animal would not regain a normal blood pressure after defibrillation and did not survive. Four (33%) survived

TABLE 2.—*Arterial Oxygen Saturations of Cyanotic Group*

Dog No.	37 C, Vol. %	23 C, Vol. %
787	14.8	--
1240	15.5	20.1
2010	16.6	20.6
1331	14.6	--
1297	17.5	19.6
977	17.4	15.1
1359	20.4	21.9
1487	13.9	16.1
1591	19.9	22.7
1617	18.2	21.7
4387	11.5	--

TABLE 3.—*Results Following Defibrillation of Hypothermic Dogs*

	No. of Dogs	Not Resuscitated	Resuscitated		Total
			Survived 24 Hr. But < 7 Days	Survived > 7 Days	
Cyanotic	12	1	4	7	11 (92%)
Pulmoaortic fistula	15	7	2	6	8 (53%)
Controls	12	1	2	9	11 (92%)

the experiment but did not live seven days. The remaining seven (58%) were long-term survivors (Table 3). Thus, 92% of this group were resuscitated. None of the survivors showed evidence of neurological damage, despite 30 minutes of ventricular fibrillation.

2. *Pulmoaortic Fistula Group.*—Fifteen dogs with pulmoaortic fistula were used (Table 3). These were divided into two groups. Seven animals were given no drugs except the pentobarbital anesthesia necessary for cooling. Only three of the seven were long-term survivors. One dog lived four days. Three could not be resuscitated, although they were defibrillated successfully.

Eight animals constituted the second group and were digitalized prior to utilization in the hypothermia experiments. It was also decided to use epinephrine in the period following defibrillation when indicated, since we had noticed in previous experiments that a common cause of failure following successful defibrillation was the inability of the dog to maintain a strong heartbeat and an adequate blood pressure. An intravenous drip of 5 mg. epinephrine per 1000 cc. isotonic saline solution was given when an adequate blood pressure was not maintained following defibrillation. No epinephrine was given prior to defibrillation. Four of the eight dogs in this latter group were given epinephrine after defibrillation, but none of these could be resuscitated. The remaining four dogs did not receive epinephrine, and three of these were long-term survivors. The fourth dog would not resume spontaneous respirations after rewarming and died of respiratory arrest. Precooling digitalization made no difference in the two groups (Table 4).

The precooling pulse pressures of all groups are compared in Table 1. The average pulse pressure of nonsurvivors of the pulmoaortic fistula group was twice that of the control animals, while the survivors had a lower pulse pressure than the nonsurvivors. Pulmonary edema was present in both survivors and nonsurvivors.

The range in which ventricular fibrillation occurred in the dogs with the pulmoaortic fistula varied from 16.5 to 23.5 C, with an average of 20.1 C. Temperatures of defibrillation ranged from 14 to 25.5 C and averaged 20.7 C.

3. *Controls.*—Twelve normal dogs were used as controls and received no drugs other than the anesthetizing pentobarbital. These animals developed ventricular fibrillation in a range from 14.7 to 25 C, with an average of 20.6 C. The temperatures of defibrillation ranged from 17.5 to 28 C and averaged 23.1 C. One of the control dogs could not be resuscitated. Two were resuscitated but did not survive a week. The remaining nine were long-term survivors.

TABLE 4.—*Effect of Digitalis on Survival Following Defibrillation in Pulmonary Artery-Aortic Fistula Group*

	No. of Dogs	Not Resuscitated	Resuscitated		Total
			Survived 24 Hr. But < 7 Days	Survived > 7 Days	
Digitalized	8	4	1	3	4
Not digitalized	7	3	1	3	4

Comment

Defibrillation was not a problem in our experiments. When the animal was warmed sufficiently, defibrillation occurred with a standard shock in all the animals. However, the response of the animal following defibrillation did become a problem. The animal's inability to develop and maintain an adequate blood pressure following defibrillation, even though a rise in blood pressure had been attained shortly after the shock, constituted the chief cause of failure of resuscitation in these experiments. The addition of digitalis and epinephrine did not improve the animal's ability to withstand the experiment.

While most of the cyanotic and control dogs recovered from 30 minutes of ventricular fibrillation in the neighborhood of 20 C, a large number with pulmoaortic fistula under chronic heart strain and decreased cardiac reserve could not be resuscitated (Table 3). This leads us to believe that experiments on ventricular fibrillation during hypothermia in normal dogs cannot be applied to clinical situations where heart disease exists.

Shumway and Lewis [4] have reported a 92% survival rate following induced ventricular fibrillation in hypothermic dogs for intracardiac surgery. Although these authors do not advise inducing ventricular fibrillation, they state that they are prepared to accept the risk in performing surgery through the agency of hypothermia.

We agree with Shumway and Lewis that ventricular fibrillation should not be induced, but we feel that ventricular fibrillation should be strenuously avoided, especially in hearts with decreased cardiac reserve. Our clinical experience in Walter Reed Army Hospital supports this viewpoint. Better means to prevent ventricular fibrillation or to resuscitate the heart after ventricular fibrillation than are presently available will have to be found if deeper hypothermia is to provide longer operating times for intracardiac surgery. The same holds true if hypothermia is to be extended to surgery within the ventricles.

If an analogy can be made, these experiments also point up a fact that is becoming well known to clinicians; namely, that cardiac surgery should not be delayed until the cardiac reserve has been depleted and failure has appeared. The dogs in these experiments under the greatest heart strain fared the worst. It is logical that a heart with good reserve is better able to withstand the manipulations and overtaxing of cardiac surgery.

Summary

Three groups totaling 39 dogs were cooled in an ice bath until ventricular fibrillation occurred. Fibrillation was allowed to continue for 30 minutes before resuscitation was begun. One group, of 12 dogs, was made cyanotic by heart surgery prior to use in the experiments, in another group, of 15 dogs, pulmoaortic fistula was created, and the third group, of 12 normal dogs, served as controls.

Ninety-two per cent of the controls and ninety-two per cent of the cyanotic group, were resuscitated, but only fifty-three per cent of the dogs with pulmoaortic fistula under chronic heart strain were resuscitated.

The implications of this finding are discussed.

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Improved and Simplified Tidal Drainage

A Preliminary Report

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Urinary stasis with attendant cystitis has been a problem in the long-term management of patients with the indwelling urethral catheter. Tidal drainage has been offered as a practical solution to this problem. It has been our experience that the instruments presently available fail to empty the bladder and only remove sufficient fluid to relieve excessive pressure. The ideal instrument should function in such a manner that it would completely empty the bladder at any desired time interval or pressure condition. Furthermore, such an instrument to be fully practical must be self-regulatory, requiring minimal professional attention.

With these basic problems in mind, detailed experimentation has been applied toward the development of an instrument which would function to eliminate these problems.

It can now be stated that after sufficient hospital trial the instrument described below fulfills these requirements of complete elimination, pressure and time interval control, and practical usability.

This instrument can be attached to a standard I. V. pole, with a fluid reservoir above and a drainage receptacle on the floor (Figure).

Maximum intravesicular pressure may be regulated to meet variable requirements by raising or lowering point (*f*) in relation to the patient's bladder.

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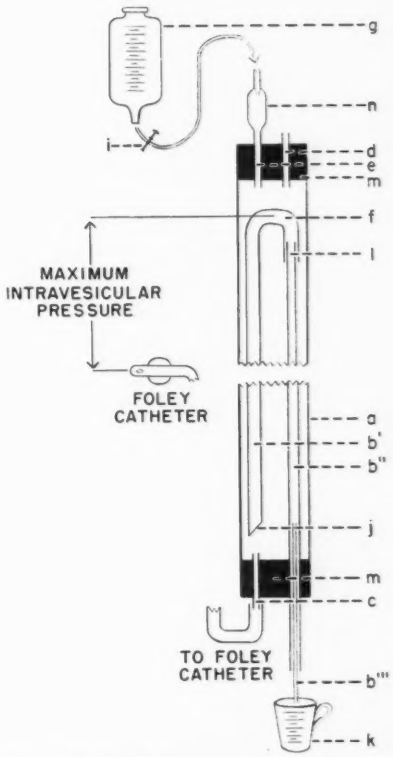
From the Department of Surgery, Hahnemann Medical College and Hospital of Philadelphia.



The parts of the instrument for tidal drainage are as follows: (*a*) Plastic cylindrical tubing, 30 in. (76 cm.) long and ¾ in. (1.9 cm.) diameter, (*b*) inverted "J"-shaped tubing within cylinder *a*; (*b'*) ¼ in. (0.6 cm.) plastic tubing; (*b''*) 3/16 in. (0.5 cm.) plastic tubing; (*b'''*) 1/8 in. (0.3 cm.) plastic tubing; (*c*, *d*, and *e*) 1½×3/16 in. (3.8×0.5 cm.) plastic tubing; (*f*) apex of siphon curve; (*g*) fluid reservoir; (*h*) drip regulator; (*i*) adjustable screw clamps; (*j*) siphon breaking point, orifice of *b'*, cut at a 45-degree angle; (*k*) fluid receptacle; (*l*) junction of *b'* and *b''* (Note: Differential internal diameter of tubing eliminates air locking); (*m*) No. 2 two-hole rubber stopper.

Fluid enters the system at point (*c*) from the reservoir (*g*) through a drip regulator (*h*). The rate of flow is controlled by a conventional adjustable clamp (*i*) above the

drip regulator. The fluid rises in the cylinder (*a*) and upon reaching the appropriate level enters the urinary bladder through tubing at point (*c*). The fluid likewise enters the siphon tubing (*b'*). As filling encroaches upon bladder capacity, pressure within the system increases, as manifest by a rising fluid level in cylinder (*a*), as well as in tube (*b'*). When point (*f*) of siphon tubing is reached, fluid will flow into the outflow tubing (*b''*) and initiate the siphon action, which will empty the system into the floor receptacle. When the fluid level in cylinder (*a*) falls below the angulated orifice of (*b'*), the siphon action is automatically terminated, and the cycle is ready to repeat itself. Since the orifice of (*b'*) is below bladder level, the bladder is completely emptied before the siphon action ceases.

Fluid must not be siphoned from the system at a rate faster than it can enter from the bladder. To safeguard this situation and prevent excessive siphoning rate, plastic tube (*b'''*) with a very small diameter is placed in (*b''*).

A 1:10,000 aqueous solution of benzalkonium chloride has been chosen for the reservoir fluid because it meets two specific requirements: (1) Its bactericidal qualities which are self-explanatory, and (2) its wetting properties, which greatly augment the proper function of the apparatus itself.

Once installed, the instrument requires no further attention than to replace fluid in the reservoir about once in 24 hours. Utilizing a graduated reservoir as well as a graduated receptacle, urinary volume can readily be calculated.

Cure of Dissecting Aneurysm of Thoracic Aorta by Total Excision

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Thus far the only reported successful surgical efforts in cases of dissecting aneurysm of the thoracic aorta have been procedures which mimic nature's occasional cure and divert the false channel back into the aortic lumen. DeBakey, Cooley, and Creech have demonstrated that good results can be obtained by dividing the thoracic aorta in the area of dissection and repairing it in such a way as to close the inner and outer coats of the distal segment, leaving a window between the two proximally. They described one case in which a dissecting aneurysm was partially resected with suture of the homograft to the approximated inner and outer walls of the distal aorta and to the aorta above proximal to the site of dissection. Occasionally a patient survives a more or less limited dissection with a persistent aneurysm. It is the purpose of this communication to describe such a case treated by total excision and grafting.

Report of a Case

The patient was a 34-year-old housewife who was admitted to the hospital on Aug. 22, 1955, because of a dull, aching pain in her left chest. Following a routine chest roentgenogram two years previously, she had been told that she had slight enlargement of the aorta. Symptoms were first noted two months before admission, when she began to have a rather vague, uncomfortable feeling deep within the left thorax. It was somewhat severer when she lay down, and on one occasion she was awakened from a sound sleep by pain. There was no history of trauma. She had had four pregnancies terminating in uneventful deliveries, the last four years before. She had enjoyed generally good health.

The patient was well developed and nourished, and physical examination was essentially normal. Blood pressure was 150/100. There were no evidences of arteriosclerosis. Blood and urine examinations revealed nothing abnormal. Serological tests for syphilis were negative. Fluoroscopic, x-ray (Fig. 1*A* and *B*), and kymographic examination of the chest revealed a lobulated mediastinal mass. Though the possibility of aneurysm was considered, the findings were erroneously interpreted as more likely indicative of a solid tumor. In retrospect, certain classical features of aneurysm were evident.

On Aug. 24, an exploratory left thoracotomy was performed, and a large aneurysm was discovered. Two days later the chest was reopened under hypothermia. The large thoracic aneurysm originated immediately distal to the origin of the subclavian artery and extended down to within 2 or 3 in. of the diaphragm. From the exterior it looked quite like an ordinary arteriosclerotic aneurysm. Freeing of the aneurysm and division between ligatures of the involved intercostal arteries was greatly facilitated by lowering the systolic blood presure to a level of about 80 mm. of Hg. with a trimethaphan camphorsulfonate (Arfonad) intravenous drip. The blood pressure was recorded continuously by means of a polythene catheter in the right radial artery, connected with an electronic recording manometer. Rectal temperature was maintained at between 28 and 29 C (82.4 and 84.2 F). The recurrent laryngeal nerve was densely imbedded in the wall of the aneurysm and was deliberately sacrificed, since it was found impossible to clamp the aorta proximally without clamping the nerve as well, and it was considered unsafe to dissect it free from the wall of the aneurysm. The aneurysm arose so close to the subclavian that it was necessary to clamp tangentially across the lateral portion of it in order to leave a small aortic cuff for anastomosis. The aneurysm was removed, and a curved nylon filter fabric graft

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From the Department of Surgery, Indiana University Medical Center. Aided by a grant from the Indiana Heart Foundation and by a contract between the Office of Naval Research, the United States Navy, and Indiana University.

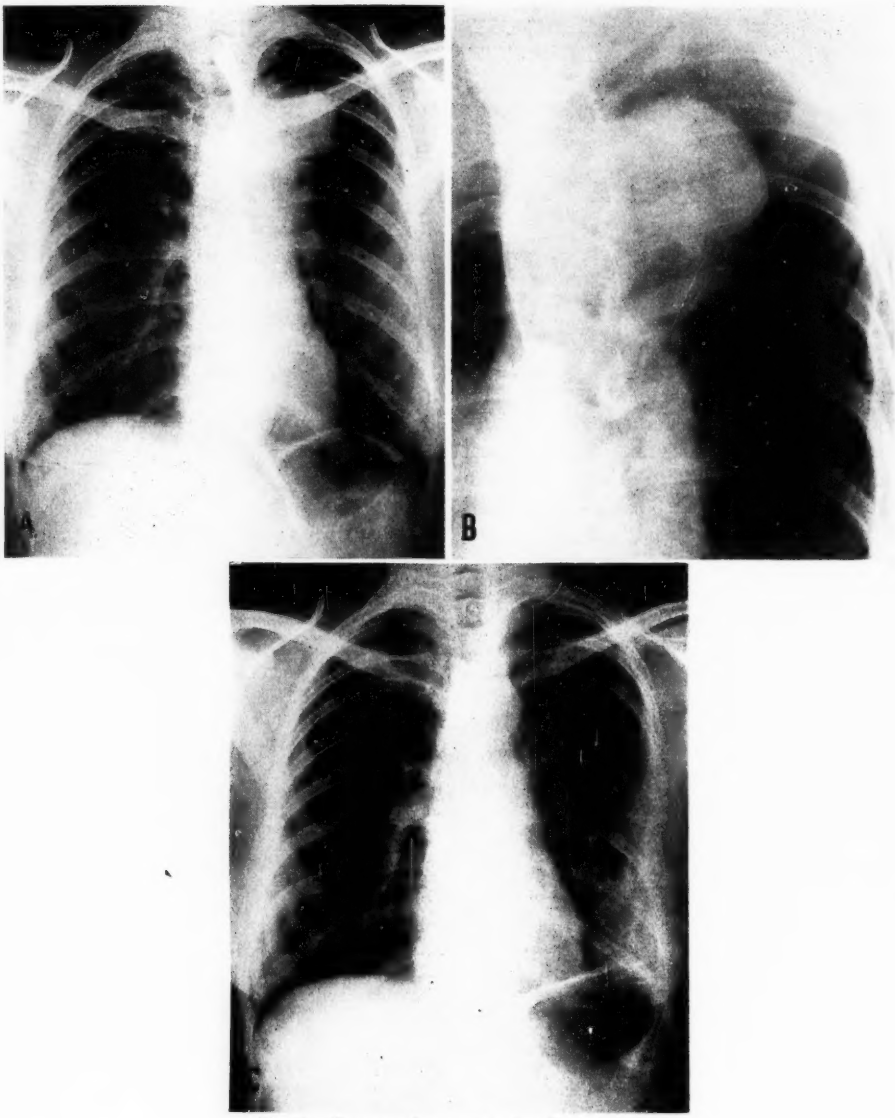

Fig. 1.—Preoperative x-rays showing extent and lobulation of the aneurysm (*A* and *B*) and postoperative film (*C*).

6.4 cm. in circumference was sutured to the aortic arch above and distal to the thoracic aorta below. The aorta was cross clamped 50 minutes. The warming process was begun, and spontaneous respirations returned at a rectal temperature of 28.4 C (83 F). When the temperature reached 35.5 C (95.9 F) the patient was returned to her room.

Postoperative recovery was relatively uneventful except for the development of third-degree burns of the sacral area and right hip and thigh, which required excision and skin grafting, and small burns of both heels, which healed without grafting. She has remained well, and a chest roentgenogram made in April, 1956 (Fig. 1 *C*), revealed a relatively normal picture.

Fig. 2.—Photographs of unopened and opened specimen. A probe has been introduced through the small perforation between the two channels.

Examination of the excised specimen demonstrated it to be a dissecting aneurysm (Fig. 2) due to cystic medial necrosis. Dissection had taken place through a very small opening, 3 mm. in diameter, through the intima and into the medial layer in the proximal portion of the descending aorta. The dissection ended at the distal portion of the resected specimen.

Comment

Though complete excision would appear to be the ideal method, such a procedure is rarely possible, since the vast majority of dissecting aneurysms originate too far proximally. Of 200 cases analyzed by Shennan, only 3 arose distal to the left subclavian and terminated proximal to the diaphragm. Of 79 old dissecting aneurysms, none was confined to this area. Most arose in the ascending aorta. In only 5 of the 32 cases reported by Gore in adults under 40 years of age did the dissection begin distal to the left subclavian, and in only 2 was the extent as limited as in our patient. Schnitker and Bayer gathered together 141 cases of dissecting aneurysm in relatively young adults, including 45 from the cases reported by Shennan. The great majority began in the ascending aorta. It would thus appear that rarely will total excision be possible.

For the majority a fenestration operations will obviously be indicated. Johns and Maier * have attempted to repair acute perforations of dissecting aneurysms externally. Though the leak was apparently stopped, neither patient survived. Both

* Maier, H. C., in discussion of DeBakey and co-workers.

Gurin, who first operated for acute dissection, and Shaw diverted the area of dissection back into the main aortic channel but at a lower level than that recommended by DeBakey and his associates, who have shown so clearly that acutely dissecting aneurysms can be managed successfully by such a surgical procedure.

Approximately half the cases of relatively young women with dissecting aneurysms collected by Schnitker and Bayer had dissections associated with pregnancy. In our patient the aneurysm was known to have been present from x-ray studies for two years. Her last pregnancy was four years prior to surgical treatment. Whether it was a causative factor is a matter of speculation. Gore and Schnitker and Bayer encountered a high incidence of associated anomalies in their cases, especially vascular anomalies, such as narrowing or true coarctation of the aorta. None was evident in our patient. As is usual, the underlying pathology in our case was cystic medial necrosis.

Summary

Because of the grave outlook in untreated cases of acutely dissecting aneurysm, the fenestration operation as proposed by DeBakey and his associates constitutes a rational method of management. Of those patients who survive an acute dissection without operative treatment, a few will have aneurysms which are so situated that they can be completely excised. One case so treated is described.

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Villous Adenoma of the Colon Associated with Severe Hypopotassemia

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Introduction

A copious mucoid discharge is a frequently mentioned and characteristic symptom of villous adenoma of the colon. The association of this discharge with severe hypopotassemia has not hitherto been noted in the literature. This report concerns such an instance in which potassium balance presented the major problem in management.

Villous adenomas of the rectum and colon are uncommon, representing 1.4% to 2.3% of surgically resected neoplasm of this region.* They occur equally in males and females and in an older age group than do adenomatous polyps or carcinoma. They are more likely to be solitary tumors than carcinomas or adenomatous polyps of the large bowel. The overwhelming majority are in the rectum, but cases have been reported from other sites in the colon.†

They are characteristically large broad-based growths with innumerable finger-like projections into the lumen. They are soft to the touch and move freely over the underlying muscularis, and so they may be missed on physical examination. Mucus secretion by the tumor is characteristic. They attain a large size by lateral extension before they cause symptoms of bleeding, tenesmus, mucoid diarrhea, or protrusion. They rarely cause large bowel obstruction.‡

Villous adenoma are composed of tall columnar epithelial cells with vacuolated cystoplasm and elongated nuclei at varying levels in the basal portions of the cell, giving an impression of pseudostratification.[3] The cells are supported on vascular villi in papillomatous proliferation. In true villous adenoma this benign morphology predominates. However, foci of carcinoma in situ or invasive adenocarcinoma are commonly found on careful search. Bacon and coworkers found an incidence of malignancy in 35.7% of their cases in which there was no preoperative evidence of malignancy. Only 25% showed the classical benign structure throughout, while 38.6% showed atypism consisting of the near-malignant changes of hyperchromatism, stratification, and nuclear and cytoplasmic irregularities. Sunderland and Binkley found that 68.7% of 48 villous adenomas contained foci of carcinoma in situ and 39% of the total had invasive adenocarcinoma. Of these 19 carcinomas, 11 were Grade 2 or 3. Fisher and Castro made serial sections in four cases in which all biopsy reports were benign. All revealed foci of carcinoma in situ, and three showed invasive carcinoma.[6] Welch found an incidence of frank carcinoma of 22% and attributes this low figure to early and radical surgery.[12] Local excision of villous adenoma therefore must be undertaken with caution, and in the great majority of cases a more radical removal of the rectum as by abdominoperineal resection is indicated.[4]

Report of a Case

An 82-year-old white man was admitted to the First Medical Division of Bellevue Hospital on

Submitted for publication July 10, 1956.

From the First Surgical Columbia University Division, Bellevue Hospital.

* References 1 and 9.

† References 2 and 5.

‡ References 7, cited by Burns,[3] and Reference 8.

Oct. 10, 1954, with a chief complaint of severe weakness. He was entirely well and able to climb five flights to his attic room until three weeks prior to admission, when he was found to be too weak to get out of bed. He complained of anorexia, mild abdominal pain, and a constant diarrhea, productive of large amounts of almost pure mucus. He denied vomiting, hematamesis, and melena. Physical examination revealed an elderly white man who appeared chronically ill and dehydrated. His temperature was 99.9 F; pulse rate, 94, respirations, 17, and blood pressure, 130/90. There was slight narrowing of the fundus arterioles. The neck veins were not distended. The lungs were clear, and the heart was normal. The abdomen was soft, nontender, and not distended. The urinary bladder was palpated at the umbilicus. Rectal examination revealed a large soft friable mass filling the lumen, starting 3 cm. from the mucocutaneous junction and extending beyond the upper limit of the examining finger. Proctoscopy revealed a broad-based, villous growth completely encircling the rectosigmoid and preventing further introduction of the proctoscope. It appeared to be producing large quantities of mucus.

Laboratory investigation revealed a hemoglobin level of 15.6 gm. per 100 cc., a white blood cell count of 6800 per cu. mm., and normal urine. Blood chemistry determinations revealed blood urea nitrogen to be 21 mg. per 100 cc., sodium 132 mEq. per liter, potassium 2.7 mEq. per liter, serum albumin 3.9 gm. per 100 cc., CO_2 48 vol. %, chlorides 100 mEq. per liter, globulin 1.5 gm. per 100 cc., and calcium 10 mEq. per liter. A chest x-ray revealed slight widening of the aorta and a normal cardiac contour. A flat film of the abdomen revealed a small amount of gas in the small bowel. Electrocardiogram revealed regular sinus rhythm, complete left bundle branch block, first degree heart block, and left axis deviation. Biopsy of the rectal mass revealed a villous adenoma composed of tall columnar epithelial cells with long narrow tapering nuclei. The cells were arranged in a regular pattern in papilliform proliferation with no evidence of atypism. The patient was transferred to the First Surgical Division.

The urinary retention was controlled with a Foley catheter. During the first six weeks of hospitalization, the course was marked by severe muscular weakness, somnolence, apathy, and abdominal distention associated with the production of up to 3 liters of clear mucus per rectum. His serum potassium remained below 3 mEq. per liter despite 40 to 120 mEq. of potassium intravenously daily as well as 1 liter of orange juice orally. The blood CO_2 content rose to 70 vol. %, and the chloride dropped to 70 mEq. per liter. The urine remained acid despite the alkalosis. The difficulty in maintaining a normal serum potassium level was finally explained on Nov. 28, 1954, when analysis of the mucus secreted by the tumor revealed that it contained 80 mEq. of potassium per liter. The daily intravenous potassium dose was increased to up to 160 mEq., which successfully maintained the serum potassium level at between 4 and 5 mEq. per liter.

The patient initially refused surgery but later consented to a limited procedure. On Dec. 2, 1954, a posterior proctotomy with resection of the coccyx was performed, but the tumor was found to be too extensive for a limited procedure, having extended well into the sigmoid. Generous multiple biopsies at this time were reported as benign villous adenoma. On Dec. 10, 1954, a sigmoid colostomy was performed under local anesthesia. Following this, the patient's strength seemed to increase, and

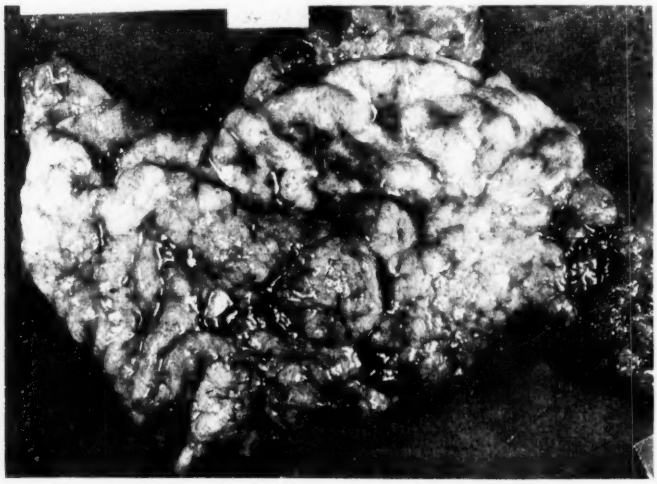

Fig. 1.—Gross appearance of tumor following abdominoperineal resection. Note the mucus covering the surface

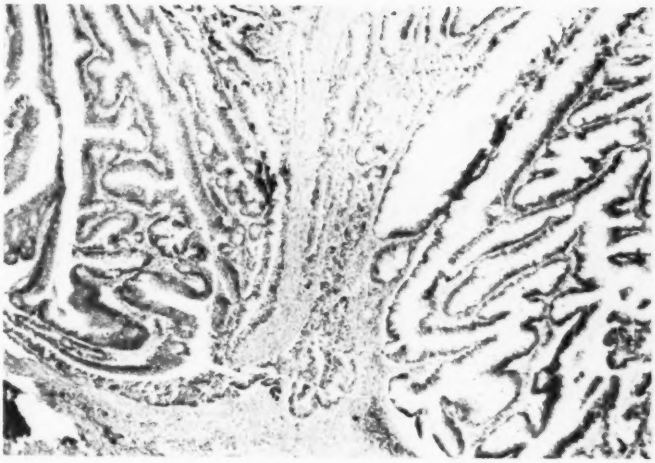

Fig. 2. — Microscopic appearance of specimen, demonstrating large amounts of mucus in the tumor cells and junction of villous adenoma with frank adenocarcinoma.

Fig. 3. — Microscopic appearance of resected specimen, showing area of invasive adenocarcinoma.

on Jan. 4, 1955, the second stage of the abdominoperineal resection was performed. There was no gross lymph node involvement.

Pathological examination of the specimen revealed villous adenoma with carcinomatous change and secondary carcinoma in the paracolic nodes.

The postoperative course was uneventful except for auricular fibrillation controlled with digitalis. The serum potassium level was maintained without additional intravenous medication. The patient's somnolence and weakness disappeared, and he was discharged on April 28, 1955.

Comment

Following the report of Darrow in 1946 of fixed alkalosis and its response to potassium therapy, there have been numerous reports of potassium-deficiency states in a variety of diseases. Hypopotassemia and the associated symptoms of muscular weakness, apathy, distention, and ileus is a well-recognized condition in surgical patients. The average potassium level of large bowel contents obtained by cecostomy is 20.6 mEq. per liter, with the highest, reported by Randall, of 47.3 mEq. per liter.§

In the present case report, the daily loss of 1 to 3 liters of mucus containing 80 mEq. of potassium per liter presented a difficult

§ References 10 and 11.

and hitherto undescribed problem in the management of villous adenoma.

Dr. James S. Johnston played a significant part in the clinical management of the case presented.

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Tetralogy of Fallot with an Innominate Artery Aneurysm

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The tetralogy of Fallot has become a well-recognized entity, readily diagnosed and partially or totally corrected by various surgical procedures.* During the diagnostic evaluation and the surgical exploration, a wide variety of associated anomalies have been encountered and described. Variations of the great vessels are the commonest, and, in reviewing 610 cases with operation, Blalock and Bahnson[4] found 140 right aortic arches, 26 retroesophageal subclavian arteries, 1 double aortic arch, and 1 instance of absence of the innominate artery on the left. To date, so far as can be determined, no case of an aneurysm of the innominate artery associated with pulmonic stenosis has been published. The following case is that of a typical tetralogy of Fallot and an aneurysm of the innominate artery.

Report of a Case

A 22-year-old white female student was admitted to Mississippi State Sanatorium on Dec. 9, 1952, because of an undiagnosed lesion in the apex of the left lung. Nine months previously, the patient had an attack of pleurisy with malaise and three episodes of gross hemoptysis. She improved slowly through the summer and entered junior college in the fall. Here, a routine mobile film was interpreted as suggestive of tuberculosis, and the patient was referred to the sanatorium.

She gave a history of heart disease since the age of 4 years, with no known difficulty prior to that time. It was noted that she turned blue following any activity or exposure to cold. She was put on bedrest from age 5 until age 9 "because they thought I was going to die." At age 11 she spent six additional months in bed. Subsequently, she led a relatively normal life except for very limited exertion. Over the intervening years, her cyanosis and dyspnea had diminished slightly. She denied rheumatic fever by name and symptoms and had never noted orthopnea, edema, genitourinary symptoms, or episodes of squatting or syncope. Dark spots had been noted to appear at intervals under the fingernails, but there had been no other symptoms suggestive of a subacute bacterial endocarditis.

Physical Examination.—Physical examination revealed a well-developed, slender, white woman, with a dusky hue to face and skin, suffused mucosae, marked cyanosis of the nail beds, and clubbing of the fingers and toes.

The neck was slender, and a prominent pulsation could be seen and felt at the right suprasternal notch, where there was a 2-cm. pulsatile mass with a pronounced thrill.

Chest: The sternum showed forward bowing, more marked on the right. The lungs were clear to percussion and auscultation. The heart was not enlarged to percussion, the PMI being in the fifth interspace at the midclavicular line.

Over the precordium could be heard a peculiar loud murmur which was continuous, with a pronounced systolic accentuation, and best described as "someone sawing wood in a large, empty hall." It was maximal over the right supraclavicular mass but could be heard over the shoulder and down the back to the right of the thoracic spine. There was also a faint thrill with a soft systolic murmur just to the left of the sternum in the second and third interspaces. Both the first and the second sounds were audible at the pulmonic and mitral regions, though P_2 was much softer than A_2. The blood pressure in the right arm was 105/70 and in the left arm 98/70.

No masses could be felt in the abdomen. The extremities showed no edema or splinter hemorrhages, and the remainder of the examination disclosed an essentially normal condition.

Laboratory Data.—There were 6,100,000 red blood cells and 6600 white blood cells per cu. mm., with 77 polymorphonuclear leukocytes and 23 lymphocytes per 100 cells. The hemoglobin was 130%, with a hematocrit reading of 68.5%. The

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From the Mississippi State Sanatorium and the Department of Surgery, University of Mississippi Medical Center.

* References 1-3.

urine gave an alkaline reaction; specific gravity was 1.010; tests for albumin and sugar were negative, and there were three to five white cells per high-power field. The serologic test for syphilis was negative. Stool examinations revealed no blood or parasites. Three sputum series, each consisting of five 24-hour specimens, were negative for acid-fast bacilli and fungi. Sputum cultures, likewise, were negative.

Roentgenographic Data.—Chest x-rays revealed cystic mottling of both lung apices, which was more extensive on the left. The heart was boot-shaped, with enlargement of the right ventricle. The aortic shadow appeared enlarged, and the aortic window was completely clear. The pulmonary vascular markings were extremely faint. At the right apex, just lateral to the mediastinum, was a rounded 2-cm. mass.

Intravenous angiocardiograms (Fig. 1) on Dec. 23, 1952, revealed delayed emptying of the superior vena cava, with the radiopaque medium entering the right auricle and then simultaneously both the right and the left ventricles. Almost no dye entered the pulmonary vascular system, but outlined an extremely large aorta measuring 5 cm. in diameter. At the distal end of the innominate artery was a 2-cm. dilation from which could be seen issuing the right subclavian and right carotid arteries.

Fig. 1.—Intravenous angiocardiogram showing simultaneous opacification of both ventricles, extremely large aorta, clear pulmonary window, and markedly diminished pulmonary vascular markings. The innominate aneurysm can be seen at the extreme right apex.

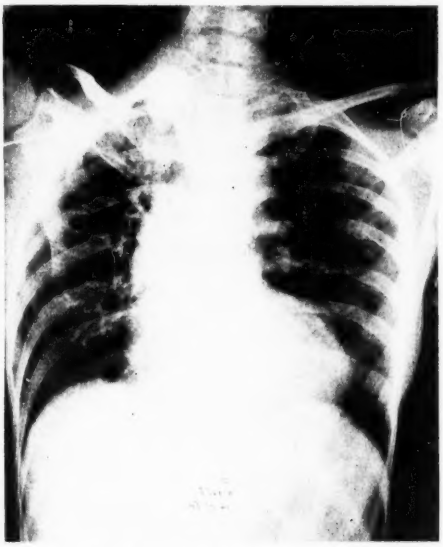

Fig. 2.—Retrograde aortogram showing aneurysm. Note the boot-shaped heart, clear lung fields, and cystic mottling of the left apex.

On Dec. 30 retrograde aortography was performed, with a catheter being passed into the aorta through the right ulnar artery. Iodopyracet (Diodrast) solution was injected and revealed a small aneurysm of the innominate artery at the point of bifurcation into the subclavian and the carotid arteries (Fig. 2).

A preoperative diagnosis was made of tetralogy of Fallot and aneurysm of the innominate artery. It was decided to attempt a valvulotomy of the pulmonary valve if feasible and, if not, to perform a systemic-pulmonary-artery anastomosis. It seemed preferable to attack only the tetralogy at this time.

Operation.—On Feb. 7, 1953, with the patient supine, a left submammary incision was extended into the chest through the third intercostal space. The third and fourth costal cartilages were divided, and the internal mammary artery was doubly ligated and divided. The lung was densely adherent at the apex and over the entire posterior and lateral aspects of the chest wall. No attempt was made to free this, as its extreme vascularity testified to an extensive collateral to the lung. The heart was found to be slightly enlarged, with a marked concavity at the pulmonary conus region. The aorta itself measured 5 cm. in diameter. When the pericardium was opened anterior to the phrenic nerve, the main pulmonary trunk was found to be only 5 mm. in diameter, with almost no systolic thrust. There appeared to be a long, narrow, thick-

walled infundibular channel, making a valvulotomy or infundibulectomy out of the question. The left pulmonary artery was dissected out and found to measure only 3 mm. in diameter. There were many dilated bronchial arteries, one of which was even larger than the pulmonary artery. The subclavian artery was found to be much too large to use for the anastomosis. Accordingly, the costocervical trunk was dissected out, and one branch of this proved to be of equivalent diameter to the left pulmonary artery. The left pulmonary artery was ligated at its origin and divided after temporary occlusion of the vessel distally. An end-to-end anastomosis was performed between the costocervical branch and the distal end of the left pulmonary artery, using interrupted everting mattress sutures of 00000 arterial silk. After removal of the clamps, a prominent pulsation and thrill were noted in the pulmonary artery. The subclavian artery was tacked to the mediastinal structures with a few interrupted nonabsorbable surgical (silk) sutures in order to maintain the anastomosis free of any strain. The lung was reexpanded and the chest closed with water-seal drainage.

The postoperative course was quite benign. Immediately postoperatively, it was evident that the patient's color was much improved. Miosis of the left eye was present, indicating that the left sympathetic trunk had been divided, probably during the dissection of the left subclavian artery. During the second postoperative week, splinter hemorrhages were noted under the left fingernails, though the patient was otherwise completely asymptomatic. Eleven blood cultures were negative, and the patient was discharged on the 21st postoperative day.

Follow-Up.—The patient returned on Aug. 2, 1955, for reevaluation as to possible surgery for the innominate aneurysm. In the intervening two and a half years, she had noted great improvement with markedly diminished fatigability. She was able to work an eight-hour shift as a nurse's aide without difficulty and could climb one flight of stairs easily, though two flights caused dyspnea. She had gained 10 lb. since discharge and had noted no edema, cough, orthopnea, sputum, hemoptysis, chest pain, fever, chills, sweats, or systemic symptoms. No further splinter hemorrhages beneath the fingernails had been observed.

On physical examination, the conjunctiva and mucous membranes were now almost normal. The left pupil remained slightly smaller than the right, but there was no ptosis, and both pupils reacted to light and in accommodation.

Neck: The small pulsating mass at the right suprasternal notch and the murmur remained exactly as before.

Chest: The heart was not enlarged to percussion. There were a faint thrill and a continuous murmur to the left of the sternum in the second and third interspaces. P_2 at this time appeared equal to A_2.

The incision was well healed, and the lungs were clear to percussion and auscultation.

Extremities: The nail beds appeared slightly cyanotic. The left arm had the same strength, temperature, and degree of moisture as the right. However, no radial or brachial pulse could be felt, nor could a blood-pressure reading be obtained on the left.

The chest x-ray at this time revealed the pulmonary vascular markings to be greatly increased over the preoperative status, with almost normal prominence at the region of the pulmonary conus (Fig. 3).

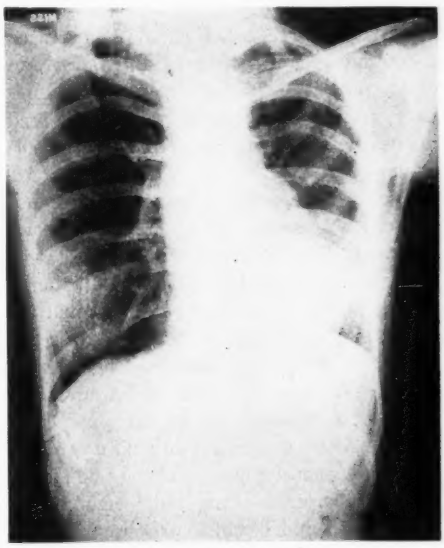

Fig. 3.—Postoperative film showing the enlarged pulmonary conus and increased vascular markings.

Laboratory Data: There were 5,900,000 red blood cells per cu. mm., with 18.5 gm. of hemoglobin per 100 cc. and a hematocrit reading of 58%.

While the improvement had been striking, the result, as anticipated, has been far from perfect. It was thought that the risk of operating on the innominate aneurysm in a person with polycythemia and a known increased tendency for thrombosis would present a greater hazard than the threat of the small nonprogressing innominate aneurysm. Accordingly, no further surgery was recommended at this time.

Comment

This combination of a typical tetralogy of Fallot with an aneurysm of the innominate artery is the first to be recorded. At operation, a thick infundibular stenosis and extremely hypoplastic pulmonary arteries were found. This condition was treated by an end-to-end anastomosis between a branch of the costocervical trunk of the subclavian artery and the left pulmonary artery.

The choice of operation was according to the usual preference for an anterior approach in a valvulotomy, if possible, or for a shunt procedure, if such is not feasible. The anterior approach, likewise, is preferable if there are adhesions with increased collaterals between the lung and the lateral chest wall. The minute size of the pulmonary artery in the present case rendered impossible either a valvulotomy or a pulmonary-aortic anastomosis.

Such minute pulmonary arteries are not unusual in the tetralogy. Campbell and Deuchar,[5] in reviewing 200 consecutive cases with operation, encountered 4 patients in whom no pulmonary artery could be found and 2 patients with such atretic arteries that no anastomosis was performed. Johns, Williams, and Blalock[6] found that 22 of 95 autopsied tetralogy cases had complete pulmonary atresia, with no communication between the heart and the pulmonary trunk, 19 arteries being quite small, 2 of normal size, and 1 completely absent. However, they point out that this series constitutes the severer cases and is not necessarily representative.

In this case, there was some debate whether any anastomosis would be of value. In order to obtain a matching vessel, it was necessary to use only a small branch of the costocervical trunk instead of the subclavian artery itself. However, the clinical result has suggested to all observers that a significant quantity of blood has been added to the pulmonary circulation. Accordingly, we have not regarded any condition as inoperable if a patent vessel of any size can be demonstrated. It is gratifying to see the pulmonary arteries enlarge enormously after becoming subjected to the higher pressure of the systemic flow.

It was hoped that the result might be sufficiently good to justify a later attack on the aneurysm of the innominate artery. While improvement was definite, both subjectively and objectively, it was limited. The persistent polycythemia and the imperfect correction of the pulmonary insufficiency appeared to militate against direct attack on the innominate aneurysm, even with the use of shunts. These patients manifest a marked tendency to cerebral thrombosis, and this aneurysm, while noisy, was not thought to be particularly threatening.

The etiology of the innominate aneurysm in the present case is uncertain. As it is small, involves the origin of the right carotid and subclavian arteries, and appears to have been present for some years without change, it is possibly congenital in origin. This is supported by the association of other congenital cardiovascular anomalies. Wolffe[7] reported an innominate aneurysm in a 7-year-old giri having rheumatic heart disease and coarctation of the aorta with no evidence of syphilis. The child was still living 10 years later with little disability from this combination of defects. In the present case also, there is an absence of other possible etiologic agents, such as syphilis, hypertension, or arteriosclerosis. It is interesting that Gay and Walker[8] were unable to find an authenticated case of a pure arteriosclerotic aneurysm in the medical literature. Nearly all have been due to syphilis. Mycotic aneurysms may occur at any point, but there is no evidence for such here.

Shumacker,[9] in reviewing the cases of innominate aneurysms treated surgically, found the cure rate low and the operative mortality high, though decreasing in recent years, and pointed out the high incidence of cerebral complications. Of 38 patients, 4 died with cerebral thrombosis and others developed hemiplegia. Blalock, early in his

operative experience with tetralogies, utilized the innominate artery for anastomosis to the pulmonary artery. As this was found to be attended with an excessive incidence of cerebral thrombosis, he advises against the use of this vessel. Campbell and Deuchar [5] came to the same conclusion after early use of the innominate and carotid arteries.

Kirby and Johnson [10] have reported the successful resection of a saccular aneurysm of the innominate artery, with reestablishment of continuity by end-to-end anastomosis. Here, again, the procedure was complicated by cerebral thrombosis in spite of preoperative carotid compressions. Hardy [11] was able to excise a saccular aneurysm of the innominate artery without resecting the innominate vessel itself. This preserved blood flow during the procedure and, thus, assured prevention of cerebral complications. Keefer, Lazzarini, and Frank † have successfully resected an innominate aneurysm, utilizing a homologous graft for restoration of continuity. This appears to be the most promising method in diffuse or fusiform aneurysms.

In general, it appears preferable to use some type of temporary shunt which would preserve cerebral blood flow during the period of innominate occlusion. In the usual case, this would allow a definitive, unhurried approach without the fear of catastrophic neurologic sequelae. The possibilities of circulatory difficulty with the arm during the period of temporary or permanent occlusion appears slight.[12] Likewise, it is doubtful that occlusion of the vertebral artery would be of any significance.

Summary

A case of typical tetralogy of Fallot with a fusiform aneurysm of the bifurcation of the innominate artery is reported. This is the first such case to have been observed. Improvement was obtained in the pulmonary circulation by an end-to-end anastomosis of a branch of the costocervical trunk of the left subclavian artery to the distal end of the diminutive left pulmonary artery. Improvement, while marked, has not been judged sufficient to warrant direct surgical attack on the innominate aneurysm.

† Keefer, E. B. C.; Lazzarini, A. A., and Frank, G.: Clinical Applications of Blood Vessel Replacement, read before the 28th Scientific Session of the American Heart Association, New Orleans, Oct. 22, 1955.

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Use of Commercial Dacron Fabric in the Repair of Inguinal Hernias and Abdominal Wall Defects

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The purpose of this paper is to report the favorable experiences in the use of commercial Dacron fabric as a prosthesis in the repair of inguinal hernias and large abdominal wall defects where a deficiency of satisfactory fascial layers exists.

Many inguinal hernias and abdominal wall defects by their very extensive nature prevent the usual surgical repair by the use of the patient's own surrounding fascial tissues. Therefore, prostheses, such as fascia lata grafts,[1] buried skin grafts,[2] tantalum wire mesh,* Surgaloy steel[6] mesh, nylon mesh,[7] Fortisan fabric,[8] and polyvinyl alcohol[9] sponge have been utilized either to reinforce weak fascial layers in hernial repairs or in some cases to support defects and to stimulate a fibroblastic reaction in order to develop a new fascial layer sufficient to prevent hernial recurrence.

Certain characteristics of these prostheses will often justify the use of one in preference to another. Recently, tantalum wire mesh has enjoyed popularity because of the apparent inertness of the tantalum and its ability to withstand infection.[10] The disadvantages of fragmentation, wire migration, and surgical reluctance to implant a stiff, unyielding prosthesis in the vicinity of large blood vessels, such as the femoral vessels, or in the neighborhood of delicate structures, such as the vas deferens, prompted the use of Dacron fabric, particularly since woven nylon, Orlon, and Dacron synthetic polymers have been shown to be so well tolerated in vascular surgery.[11] Nylon mesh has been used and reported as a satisfactory prosthesis in a limited number of ventral and inguinal hernial repairs.†

In this series commercial Dacron fabric of 40 denier was used in the repair of 15 inguinal hernias. All of these wounds in which Dacron was used have healed per primam, and there has been no clinical evidence of induration or serum collection except for one wound in a patient with the diagnosis of Laennec's cirrhosis and carcinoma of the stomach, which required aspiration of 15 cc. of serum on the sixth postoperative day.

Four ventral hernias have been repaired, using a slightly heavier Dacron fabric, of 70 denier. All of these defects were 10 cm. or more in diameter. Because of the dissection necessary to free these large ventral hernial sacs and the inadvertent cutting of many lymphatic vessels, these hernial repairs were drained postoperatively. They have all healed without infection, excessive drainage, or postrepair tenderness.

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From the Surgical Service of the Veterans Administration Hospital.

Read before the General Session on Surgery at the 190th Annual Meeting of The Medical Society of New Jersey, in Atlantic City, on May 14, 1956. This paper has been released for publication here through the courtesy of "The Journal of The Medical Society of New Jersey."

* References 3-5.

† References 7 and 12.

Data on Use of Dacron Fabric Prosthesis

Case	Age, Yr.	Reason for Insertion	Date of Operation	Comment
1	72	Rt. inguinal hernia; fascial deficiency	10- 4-55	Sutures removed 7th p.o. day; Wd. well healed
2	43	Lft. inguinoscrotal hernia	10-13-55	Sutures removed 7th p.o. day; Wd. well healed
3	58	Bilateral inguinoscrotal hernias	Rt. 10-21-55 Lft. 11-14-55	Healed without infection Sutures removed 9th p.o. day; Wd. well healed
4	55	Rt. inguinal hernia; fascial deficiency	10-25-55	Sutures removed 7th p.o. day; Wd. well healed
5	42	Rt. inguinal hernia; recurrent	10-31-55	Sutures removed 7th p.o. day; Wd. well healed
6	59	Rt. inguinal hernia; fascial deficiency	11-22-55	Aspiration of 15 cc. of serum on 6th p.o. day; sutures removed 7th p.o. day; Wd. well healed
7	66	Lft. inguinal hernia; fascial deficiency	11-28-55	Sutures removed 7th p.o. day; Wd. well healed
8	63	Lft. inguinal hernia; fascial deficiency	12-15-55	Sutures removed 6th p.o. day; Wd. well healed
9	34	Rt. inguinal hernia; 3d recurrence	12-15-55	P.o. ecchymosis; sutures removed on 12th p.o. day
10	62	Rt. inguinoscrotal hernia	12-20-55	Sutures removed on 6th p.o. day; Wd. well healed
11	45	Metastatic tumor to abdominal wall	1-10-56	Sutures removed on 9th p.o. day; Wd. well healed
12	42	Ventral hernia p.o. sub. gastrectomy	2-10-56	Sutures removed 11th p.o. day; Wd. well healed
13	67	Rt. inguinal hernia; fascial deficiency	2-15-56	Sutures removed 7th p.o. day; Wd. well healed
14	80	Rt. inguinoscrotal hernia	2-16-56	Sutures removed 7th p.o. day; Wd. well healed
15	62	Rt. inguinal hernia; fascial deficiency	3-13-56	Sutures removed 7th p.o. day; Wd. well healed
16	59	Ventral hernia; p.o. volvulus of sigmoid	4-12-56	Sutures removed 10th p.o. day; Wd. well healed
17	35	Rt. inguinal hernia; 4th recurrence	4-14-56	Sutures removed 7th p.o. day; Wd. well healed
18	55	Ventral hernia; p.o. sub. gastrectomy	4-17-56	Sutures removed 7th p.o. day; Wd. well healed

The Dacron fabric was obtained from a commercial concern, supplying Dacron for textile purposes.‡ The Dacron was boiled for 30 minutes in a detergent to remove any finish or sizing.

Procedure

In inguinal hernias after the dissection of the hernial sac and its treatment, the Dacron fabric was fashioned and then sutured to the inguinal ligament laterally and to the margin of the fascia transversalis medially, which was usually located if the dissection was carried far enough under the conjoined tendon. Surgaloy sutures of No. 3-0 were utilized to suture the prosthesis into place, and care was taken to prevent wrinkling. A slit was fashioned in the Dacron to accommodate the cord. The conjoined tendon was not utilized in the repair, and the remaining portion of the procedure consisted of replacing the inguinal cord into its usual position and suturing the fascia of the external oblique over it. All of these hernias presented major fascial deficiencies or were recurrences.

In the repair of the ventral hernias, after the excessive portion of the peritoneal sac had been excised and the peritoneal cavity closed, the heavier Dacron fabric was then

‡ Manufactured by J. P. Stevens & Co., Inc., New York.

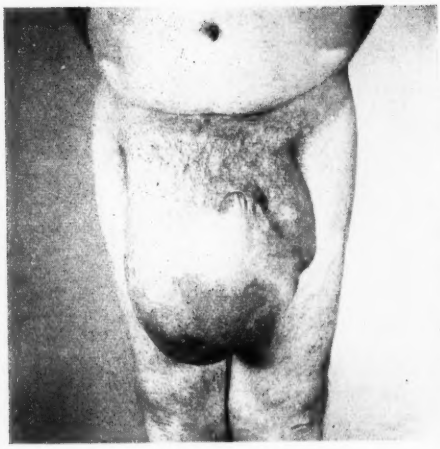

Fig. 1.—Case 3, preoperative. Bilateral inguinal scrotal hernias.

Fig. 2.—Case 3, postoperative. Three weeks following insertion of Dacron fabric prostheses bilaterally.

sutured into place to the margin of the most substantial presenting layer, and in most cases this was the remnant of the fascia of the anterior rectal sheath or the fascia of the external oblique muscle. The suture material utilized was No. 2-0 Surgaloy. A small slip of Penrose drain was inserted at the inferior margin of the wound, and this was removed on the sixth postoperative day.

Report of Cases

Case 3 (Fig. 1).—A 58-year-old white man with giant bilateral inguinoscrotal hernias of 10 years' duration. Following institution of pneumoperitoneum, a Dacron prosthesis was inserted in the repair of the right side. The wound healed well, and a repeat pneumoperitoneum was instituted, and the left side was repaired with Dacron on Nov. 14, 1955. The sutures were removed on the seventh postoperative day, and the wound was well healed. Postoperative follow-up has revealed no suggestion of weakness (Fig. 2).

Case 6.—A 59-year-old white man with a right inguinal hernia which was repaired on Nov. 12, 1955, and a Dacron prosthesis inserted because of fascial deficiency. On the sixth postoperative day 15 cc. of serum was aspirated from the wound; however, the sutures were removed on the seventh postoperative day, and the wound appeared well healed. This patient was a known cirrhotic, and

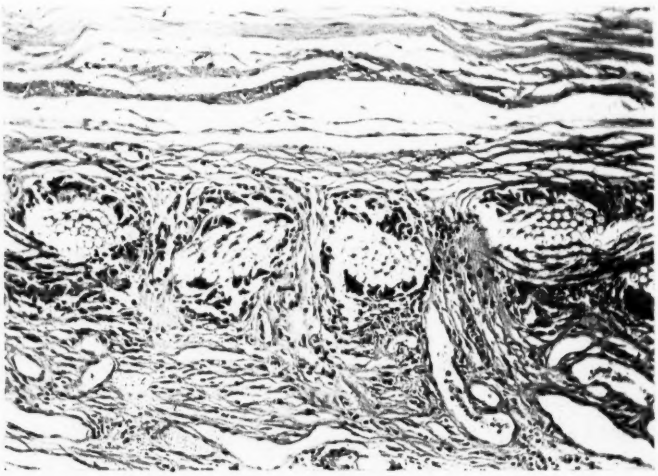

Fig. 3.—Photomicrograph of Case 6, showing tissue reaction to Dacron fabric prosthesis in place seven weeks; reduced ¼ from mag. × 300.

Fig. 4.—Case 16, preoperative. Large ventral hernia following resection of sigmoid colon for volvulus.

Fig. 5.—Case 16, postoperative. Ten days following insertion of Dacron fabric prosthesis.

prior to discharging from the hospital a diagnosis of carcinoma of the stomach was made and found to be inoperable at exploratory laparotomy. This patient died on Jan. 16, 1956, and limited postmortem examination of the hernial repair revealed the tissues well healed; the Dacron prosthesis was firmly in place, with fibrous tissue growing through the interstices of the cloth. There was no evidence of inflammatory reaction, abscess formation, or excessive foreign-body reaction (Fig. 3).

Case 16 (Fig. 4).—A 59-year-old white man with a large ventral hernia following a left rectus incision for the resection of a volvulus of the sigmoid colon. The abdominal wall defect measured 10×15 cm. A Dacron prosthesis was inserted on April 12, 1956, between the peritoneal cavity closure and the skin. The postoperative course of this patient was complicated by paralytic ileus; however, the sutures were removed on the 10th postoperative day, and the patient was discharged on the 14th postoperative day (Fig. 5).

Comment

From the experiences gained, it appears that, providing the usual surgical safeguards are taken to prevent infection, Dacron fabric can be employed as a useful hernial prosthesis, since it is easily fashioned to fit any defect, sterilizes without special care, appears well tolerated by the tissues, and is extremely inexpensive. The limited studies of human somatic tissue reaction to Dacron and experimental, noninfected rabbit-tissue studies reveal that Dacron fabric remains as a relatively inert foreign body and merely provides a type of scaffolding for the ingrowth of fibrous tissue.

The behavior and fate of a Dacron prosthesis in the presence of infection remains to be studied. From the preliminary results of studies in rabbits,§ it appears that Dacron behaves in a similar manner to those results reported by Sanford and co-workers[13] on the fate of Orlon in infected wounds in rabbits, where usually sinus tracts persisted, abscess cavities developed, and in some animals prominent granulomas were present.

Summary

In many inguinal hernias and abdominal wall defects, deficiency of natural fascial layers often necessitates the use of a prosthesis, such as fascia lata, Surgaloy mesh, tantalum mesh, or Fortisan in order to achieve a suitable repair of the defect. Commercial Dacron fabric was utilized in the repair of 15 inguinal hernias and 4 abdominal wall defects with encouraging results.

Dacron fabric appears to be a satisfactory prosthesis for the replacement of fascial

§ Unpublished experimental data.

layers, since it is easily tailored, sutured without difficulty, well tolerated by the tissues, and can always be readily available. The tissue reaction to Dacron is of a fibroblastic nature.

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Retrograde Jejunogastric Intussusception—A Rare Cause of Hematemesis

Review of the Literature and Report of Two Cases

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Retrograde jejunogastric intussusception is a serious complication of gastric surgery which, although rare and little known, is easily diagnosed and treated if its possibility is kept in mind, but which has a 100% mortality if misdiagnosed and not treated surgically. Moroney [17] states that "of all the causes of hematemesis, retrograde intussusception must be amongst the rarest—so rare that it is unlikely ever to be seriously considered." Nevertheless, since there is a strong tendency in modern practice to treat massive upper gastrointestinal bleeding during the first 24 hours in a conservative (nonoperative) manner, which in this case is disastrous, I felt that this condition warranted record. That retrograde intussusception is rare is evidenced by the fact that, from the time the first gastroenterostomy was performed in 1881, not a single case was recorded until Bozzi's report in 1914.* From the reporting of the second case in 1917 by Steher until 1933, Bettman and Baldwin [3] could find but 33 cases, only 6 of which were in the American literature. By 1944, Poliquin [19] had collected 50 cases, and Aleman [2] in 1948 reported 70 cases, including those from a comprehensive review of the European literature, adding a case of his own. Since then, I have found 10 additional case reports,† bringing the total reported cases to 81.

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Chief of Surgery, Sakbayeme Hospital (American Presbyterian Mission).

* Bozzi, cited by Adams.[1]

† References 7, 8, 11, 13-15, 18, 22.

That jejunogastric intussusception is still little known among the profession in general is shown by the evident lack of correct diagnoses in the reported cases. In no case in the literature was a correct preoperative diagnosis made until Chesterman's case [6] in 1933, and until 1944 only three more correct diagnoses had been made.[19] In nearly 30% of reported cases, the diagnosis was not made until autopsy.[21]

Report of Cases

CASE 1.—A 60-year-old African housewife entered the Sakbayeme Hospital on April 15, 1954, with the chief complaint of vomiting blood of two hours' duration.

History.—In 1937, she first entered the hospital complaining of upper abdominal pain of four years' duration, which was only partially relieved by taking food or sodium bicarbonate. A diagnosis of chronic duodenal ulcer was made, and a posterior gastroenterostomy was performed. She made an uneventful recovery, and since that time had been asymptomatic until February, 1954, seventeen years after her operation. At this time, she again noted upper abdominal pain, which, in contrast to her previous pain, was definitely made worse by food. Tenderness was found in the epigastrium, and a gastrointestinal series was interpreted as showing a possible early marginal ulcer, but no other abnormalities were noted. She was placed on antacids and a bland diet, from which she obtained definite symptomatic relief until two weeks before the present entry, when the pain again returned in spite of medical treatment. At 7 a.m. of the day of entry (April 15), she suddenly, without warning, vomited a small basinful of dark unclotted blood. She was brought to the hospital about two hours later in an agitated, highly excited condition. She did not complain, however, of abdominal pain and gave no history of passing tarry stools. The past history and systemic review were not otherwise contributory to the present illness.

Physical Examination.—The patient was a tall, thin, somewhat dehydrated Negro woman of about

the stated age, anxious and agitated. Examination showed an essentially normal condition except for the following findings: The abdomen was flat and revealed a well-healed right upper rectus scar. The epigastrium was slightly tender. A large rounded soft nontender mass was present in the left upper quadrant and was presumed to be dilated stomach filled with blood clots. The pelvic and rectal examinations revealed no abnormalities; a glove specimen showed brown stool with no trace of blood. Pulse, 90; blood pressure, 120/70; temperature, 98.4 F.

Laboratory Studies.—Hemoglobin was 10.4 gm. per 100 cc. (as compared with 12.0 gm. two months earlier). Blood was positive for malaria organisms and Filaria perstans. Stool was negative for blood, positive for roundworms. WBC, 9000 per cu. mm. Urine was not remarkable.

Hospital Course.—A preoperative diagnosis was made of bleeding recurrent duodenal or marginal ulcer and possible bleeding esophageal varices. The patient was treated conservatively with heavy morphine and barbiturate sedation, a hemostatic preparation containing oxalic and malonic acids (Koagamin) intramuscularly, and colloidal thromboplastin suspension (Thrombol subcutaneous) given orally. Hypodermoclyses were given to maintain hydration. Blood for transfusions was not available. This regimen was continued for 24 hours, during which time the blood pressure, pulse, and respiration remained relatively stable. However, during this time she vomited five times, bringing up a total of 1 liter of dark, almost black, unclotted blood mixed with gastric juice. Since it was obvious that active bleeding was continuing in spite of conservative therapy, it was decided to perform an exploratory operaton.

Operation.—The abdomen was opened through an upper midline incision, with the patient under spinal anesthesia. The stomach was greatly dilated and filled with a soft mass which at first seemed to be blood clots. The duodenum appeared normal, with no evidence of recent ulcer. The transverse colon was then elevated, and the diagnosis became immediately apparent. The distal loop of jejunum of the gastroenterostomy had intussuscepted through the gastroenterostomy stoma into the stomach (Type IIB, Fig. 1). All efforts to reduce the intussusception were to no avail. An anterior gastrotomy incision was then made. About 500 cc. of dark blood was aspirated from the stomach, and the intussuscepted mass, measuring 25 cm. in length and 8 cm. in diameter, was delivered outside the stomach. The mucosa of the mass was black and necrotic. Again an attempt was made to reduce the intussusception, working from both above and below the stoma, but without success. The distal jejunal loop was divided 6 cm. distal to the intussusception, and the intussuscepted mass was excised at the stoma. It was felt that the stoma would hold sutures; therefore, the distal jejunum was reanastomosed to the stoma, and the gastrotomy was closed. The patient received gelatin and saline solution intravenously during surgery, withstanding the procedure well, and was returned to the ward in fairly good condition.

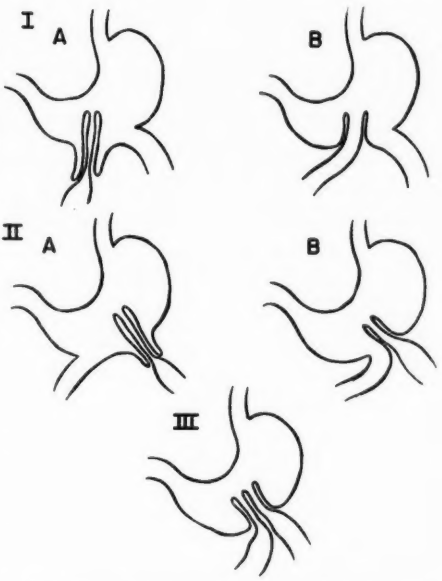

Fig. 1.—Diagram illustrating different types of jejunogastric intussusception.

Type I, intussusception of the afferent loop (10%); Type II, intussusception of the efferent loop, retrograde intussusception (74%); Type III, combined intussusception of both loops (16%).

Postoperative Course.—The day following surgery the hemoglobin was found to have dropped from the preoperative level of 10.4 gm. to 8.0 gm. per 100 cc. On the fourth day, a fecal fistula developed in the incision, drained for eight days, and then closed spontaneously, after which the patient made a slow but steady recovery. A few months later she developed an incisional hernia which was successfully repaired, and she has been relatively asymptomatic since then.

Comment.—It is interesting that the time from the first operation (1937) until the onset of symptoms (February, 1954) was 17 years. Eighteen years is the longest recorded interval in the reported cases. Although the patient had had some epigastric pain unrelieved by medical therapy in the two weeks before entry, it is remarkable

that during the acute episode, in the presence of an intussusception of sufficient duration and severity to cause massive upper gastrointestinal bleeding, the patient experienced no real pain, but merely had slight tenderness over the mass. This is in contrast to most of the other cases, in which severe epigastric pain was usually a prominent symptom.

I could find only 10 other cases ‡ in which the author definitely stated that the intussuscepted jejunum was gangrenous. In each of these cases massive hematemesis was present. However, seven of the cases were diagnosed only at autopsy; the other three were diagnosed at surgery, but none of the patients survived. Apparently, this is the first case with gangrenous intussusception in which the patient survived the operation. This would indicate the urgency of immediate surgery in these cases, especially in the presence of massive hematemesis, when one ordinarily might tend to treat the patient conservatively.

‡ References 3, 4, 12, 13, 15, 17, 24.

CASE 2.—A 30-year-old African housewife entered the Sakbayeme Hospital on March 15, 1955, with the chief complaint of severe, cramping epigastric pain of four hours' duration.

History.—This patient had had chronic lepromatous leprosy for many years and had been under treatment in our leprosy colony for more than 10 years. About 8 years ago, she first developed epigastric pain, unrelieved by food or antacids, which continued on and off until 18 months before entry. At this time, a gastrointestinal series demonstrated a deformity of the duodenal bulb. A diagnosis was made of chronic duodenal ulcer, and on Sept. 17, 1953, I performed an exploratory operation. A chronic, scarred anterior duodenal ulcer was found, and a posterior gastroenterostomy was performed. The patient made an uneventful recovery and was free of all abdominal complaints until the present entry.

Eighteen months after the gastroenterostomy, on March 15, 1955, she arrived at the hospital and complained of the sudden onset of severe, cramping epigastric pain of four hours' duration, beginning at 6 a.m. She was nauseated but had not vomited. At 7:30 a.m. she passed a normal stool and continued to pass gas until first seen at the hospital at 10 a.m.

Physical Examination.—The patient was a thin, moderately well-developed Negro woman in acute

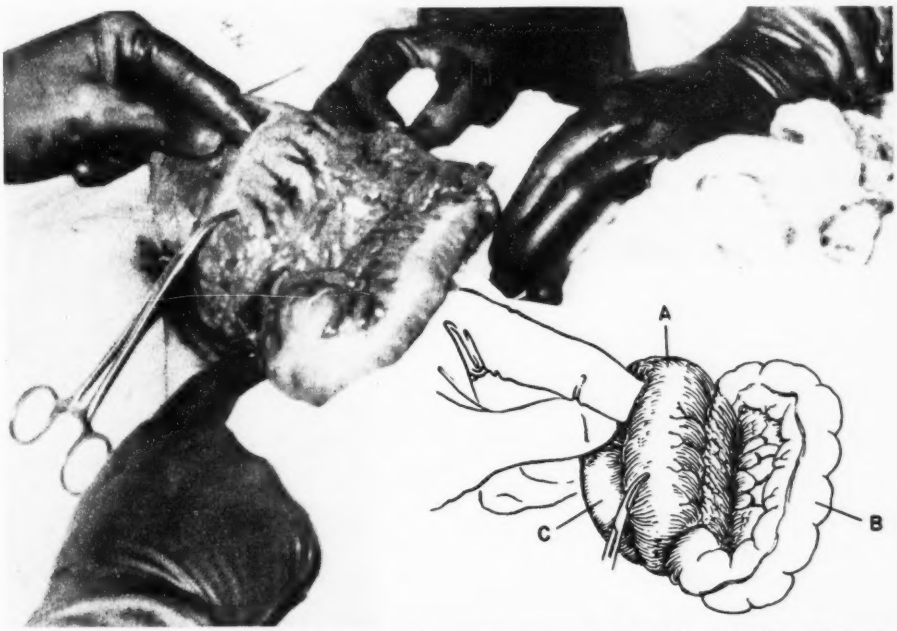

Fig. 2 (Case 2).—Stomach contained a soft, sausage-shaped mass which half filled the lumen (*A*); (*B*) transverse colon; (*C*) collapsed portion of stomach.

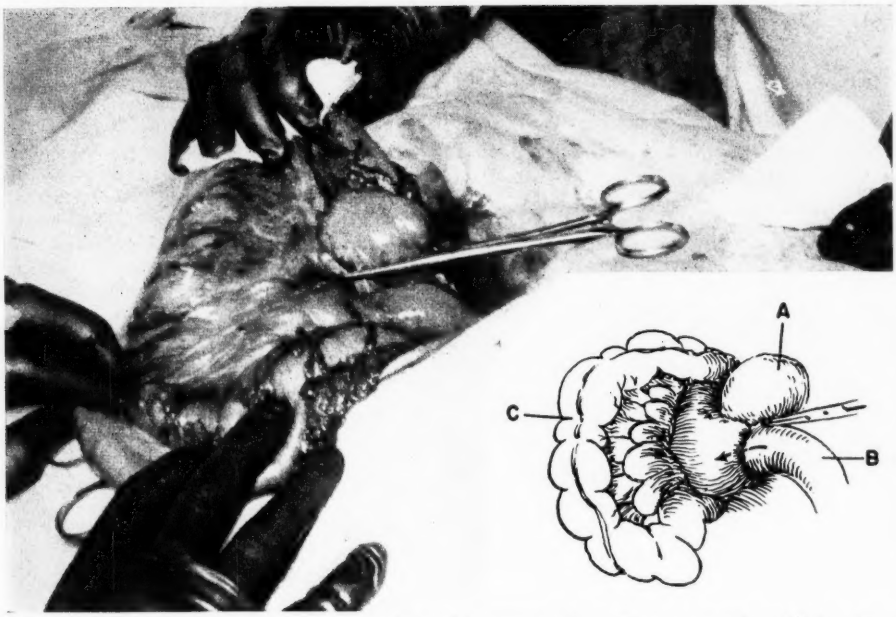

Fig. 3 (Case 2).—Illustrating point of origin of intussusception. Transverse colon (*C*) has been reflected superiorly over stomach, showing region of old gastroenterostomy stoma. Arrow indicates direction of intussusception. *A*, dilated proximal (afferent) loop of jejunum. *B*, collapsed loop of distal (efferent) jejunum just below point of origin of intussusception which is indicated by tip of clamp.

distress from cramping epigastric pain, recurring every one to two minutes. An old healed right upper rectus incision was present. At the height of a cramp, high-pitched peristaltic rushes were heard, similar to those of acute mechanical small-bowel obstruction. A soft, extremely tender mass was present in the left upper quadrant in which peristaltic waves were visible. She had no tenderness or guarding elsewhere, and her pain was sharply localized to the region of the mass. Pelvic and rectal examinations were noncontributory, as was the remainder of the physical examination. Pulse rate, 80; blood pressure, 100/70; temperature, 98.4 F.

Laboratory Studies.—Hemoglobin, 11.5 gm. per 100 cc.; WBC, 7300 per cu. mm. Blood positive for malaria organisms. Stool positive for roundworms, negative for blood. Urine not remarkable.

Hospital Course.—A nasogastric tube was passed, and about 700 cc. of odorless thick green fluid was aspirated, with no signs of blood in it. Fortunately, because of the previous experience with Case 1, the diagnosis of this case was made without delay, i. e., acute retrograde jejunogastric intussusception. The patient was prepared for operation and taken to surgery, just five hours from the onset of the pain.

Operation.—With the use of spinal anesthesia and a left upper rectus incision, the abdomen was explored. The stomach contained a soft sausage-shaped mass which filled half of the lumen (Fig. 2). The duodenum showed no signs of recent ulcer activity, and the pylorus was patent. The old posterior gastroenterostomy was inspected. It was immediately apparent that the distal (efferent) loop of the jejunum had intussuscepted into itself in a retrograde manner and entered the stomach (Type IIA, Fig. 1). The base of the intussusception was about 10 cm. distal to the gastroenterostomy stoma, and the jejunum distal to this was collapsed (Fig. 3). The proximal loop appeared normal and was not obstructed. No signs of adhesions, ulceration, or irritative processes were evident in the region of the anastomosis. The intussusception was easily reduced by taxis and gentle traction. The intussuscepted loop of jejunum was found to be 30 cm. long. After reduction, it appeared normal except for slight hyperemia of the serosal surface (Fig. 4). The stoma easily admitted two fingers. No further procedure was done. The patient made an uneventful recovery and has remained well since.

Comment.—The fact that this patient was operated on so soon after the onset of symp-

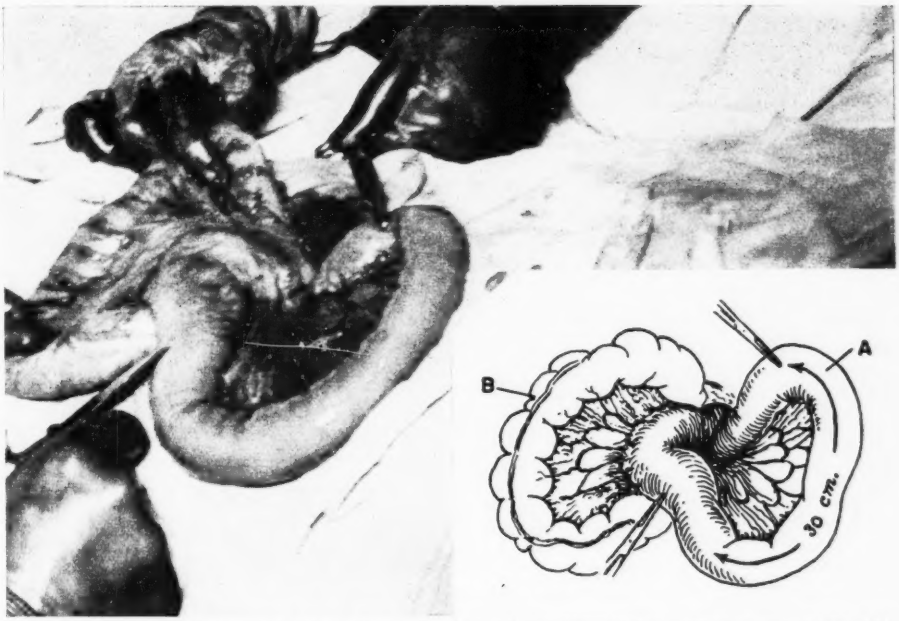

Fig. 4 (Case 2).—Photograph taken after reduction of intussusception. Transverse colon (*B*) is reflected superiorly over the stomach, showing region of old gastroenterostomy stoma. After reduction, intussuscepted loop of jejunum (*A*) measured 30 cm. in length (the distance between the points of the two clamps).

toms (five hours) was attributed to two factors. The first undoubtedly was that she lived in the vicinity of the hospital and could arrive quickly. But the second factor, of definite practical importance, was that the diagnosis was made quickly, because I was aware of this condition (from experience with Case 1). The importance of early diagnosis in these cases cannot be stressed too strongly and, in this case, was undoubtedly the main factor in the successful outcome.

To one unfamiliar with the symptomatology of jejunogastric intussusception, the diagnosis of this case could easily have been confusing. At first glance, the patient seemed to be suffering from mechanical bowel obstruction. The cramping pain, peristaltic rushes, the visible peristaltic waves were suggestive of this, but the pain was localized to the left upper quadrant in contrast to the usual pain of obstruction, which is generalized or periumbilical. Moreover, to further confuse the picture, the two cardinal symptoms of obstruction were absent, i. e., vomiting and obstipation. The absence of these in this case was probably due to the very short duration of the illness. The stomach contained fluid, but the organ had not yet had time to become distended to the point of provoking the vomiting reflex.

Comment

Retrograde jejunogastric intussusception occurs in a wide age range; the youngest reported patient [9] was 21 years of age and the oldest 75 years, with an average age of 43 years. The incidence is definitely higher in women than in men, a fact which is significant when it is remembered that the incidence of gastric surgery for ulcer is much higher in men, and that the incidence of other types of intussusception of the gastrointestinal tract is also higher in men. The reason for this increased incidence among women is not clear. The length of intestine involved varied from 4 cm. to 2 meters. In-

tussusception occurred at variable times after the original operation: 6 days was the shortest period and 18 years the longest, with an average of 6 years. In all the reported cases, with two exceptions, the original operation was performed because of peptic ulcer. The two exceptions were one case for gastroptosis [2] and one case for carcinoma of the stomach.[14] In all but six cases the original operation was a gastroenterostomy. In these six cases partial gastrectomy had been performed. The ratio of gastroenterostomy to gastric resection was roughly 13 to 1. One does not expect, therefore, to see a decreasing incidence of intussusception in the future, even though gastrectomy is rapidly replacing gastroenterostomy as the operation of choice for peptic ulcer, since intussusception occurs after gastrectomy as well as after gastroenterostomy.

Classification.—It is helpful in correlating the symptomatology with the anatomical changes if jejunogastric intussusception is classified on both an anatomical and a clinical basis. Aleman [2] proposed the following anatomical classification (shown in diagram, Fig. 1):

Type I—Intussusception of the afferent loop (10%)

Type II—Intussusception of the efferent loop, retrograde intussusception (74%)

Type III—Combined intussusception of both loops (16%)

Type I and II (simple intussusception), comprising 84% of the cases, is typically a late complication which develops on the average six years after operation. In contrast to this, Type III (combined intussusception, 16%) is usually an early complication, diagnosed in two-thirds of the cases only a few days after the operation. The other third were recognized from a few months to one or two years after operation, but the symptoms began simultaneously with the operation.

Clinical Signs.—Clinically, an acute form and a chronic intermittent form are readily distinguishable.§ The acute form is characterized by a brief illness, with sudden onset of severe, colicky epigastric pain, followed by persistent vomiting, first of food, then of bile, and finally of blood. The patient may be in moderate to severe shock. A mass may be palpable above and to the left of the umbilicus in more than 50% of the cases, but visible peristalsis and upper abdominal rigidity may be the only signs. The prognosis is grave, and surgical intervention should be immediate.

In the chronic intermittent form, the patient maintains a state of chronic invalidism following a gastroenterostomy for peptic ulcer. The characteristic symptoms, beginning at any time from 5 days up to 14 or more years after operation, are epigastric pain, nausea, and vomiting which occur at irregular intervals, are nearly always associated with meals, and subside spontaneously. In these patients immediate surgery is not so necessary as in those with the acute form. X-ray examination may aid in the diagnosis.

Diagnosis.—Early diagnosis in the acute cases is vital because there has been a 100% mortality in the cases reported up to 1950 when surgical exploration was not attempted, while early operation has proved lifesaving in 90% of the cases treated surgically.[15] The general difficulties in diagnosis are obvious.

1. Only one or two cases have been seen by any one author, and the condition is so rare that it is ordinarily not even considered.

2. In practically all the cases, the previous history of ulcer associated with hematemesis strongly suggests the recurrence of a peptic ulcer or the development of a marginal ulcer.

3. Because of the desire to let a bleeding, vomiting patient alone as much as possible for the first few days, palpation of the abdomen and x-ray examination may be deferred and the tumor mass may not be recognized.

4. The combination of hematemesis with high intestinal obstruction is rare and misleading.

5. The chronic intermittent type of intus-

§ References 5 and 15.

susception is often spontaneously reduced before a diagnosis is made.

The following aids to diagnosis were suggested by one author:

1. The possibility of jejunogastric intussusception should be thought of in cases of hematemesis in which there has been a previous gastroenterostomy or gastric resection.

2. In such cases the epigastrium should be palpated carefully and thoroughly for a tumor, in spite of the hematemesis.

3. In distinguishing intussusception from recurrent peptic ulcer, the kind of vomiting may have some value. In the majority of cases, there is first vomiting of food, then of bile, and later of blood. This is unlike the usual hemorrhage in peptic ulcer, in which the first vomiting is likely to contain blood. A tumor is rarely palpable in peptic ulcer.

Differential Diagnosis.—The differential diagnosis of both acute and chronic jejunogastric intussusception must include consideration of recurrent peptic ulcer with hemorrhage or perforation; high intestinal obstruction from adhesions, tumor, or internal hernia; disease of the biliary tract, and acute pancreatitis. Careful consideration of the following factors should serve to distinguish these conditions from intussusception. Case 2 showed the three cardinal signs and symptoms of a mass, tenderness, and epigastric pain, but no vomiting. Case 1 showed the three cardinal signs and symptoms of a mass, tenderness, and vomiting of blood, but no pain. Many reported cases showed the signs and symptoms of pain and/or vomiting, but no mass or tenderness. Therefore, in summary, we can say that any patient who has had gastric surgery and who subsequently develops either (1) severe epigastric pain, or (2) persistent vomiting (either bile-stained or bloody), or (3) a palpable epigastric mass, or (4) tenderness over the epigastrium, or (5) any combination of the preceding signs or symptoms, should be suspected of having jejunogastric intussusception until proved otherwise.

The diagnosis should also be seriously considered in cases of massive upper gastrointestinal bleeding following gastric surgery, whether with or without pain, whether with or without a palpable mass, but almost certainly if accompanied by both pain and a mass.

Roentgenologic Signs.—Of the 70 cases reported up to 1948, only 12 were roentgenologically diagnosed.[2] It would appear that x-ray examination has its chief value in diagnosis of the chronic intermittent cases. Patients with the acute condition are often too ill for such examination; the delay in operation in waiting for roentgenograms is inadvisable, and few physicians advise x-ray examination in the presence of acute hematemesis. The characteristic roentgenologic signs of jejunogastric intussusception are as follows[5]:

1. The presence within the lumen of the stomach of a partially movable filling defect have parallel curved lines simulating the normal pattern of small intestinal folds (Kerkring folds or valvulae conniventes).

2. The reentry into the stomach by way of the afferent loop and stoma of some of the barium which had previously left the stomach through the pylorus.

3. Delayed gastric emptying.

4. Some authors call attention to a dilatation of the stomach and a displacement of the pylorus to the right.

Etiology and Mechanism.—The etiology of retrograde jejunogastric intussusception is unknown. In contrast to other types of intussusception (in adults) elsewhere in the gastrointestinal tract, there is not a single case in which some anatomicopathological change found in the intussusception itself (such as tumor, ulceration, etc.) could account for the genesis of the invagination.‖ Mechanical factors, such as the type of gastroenterostomy or the size of the stoma, seem to be unrelated to its production. In a few cases, it was thought that adhesions had formed in such a way around the stoma as to favor formation of an invagination,

‖ References 2 and 15.

but this was doubtful. Therefore, most authors favor the dynamic or functional concept as being more reasonable than the mechanical concept of the etiology of this condition. They assume that local spasm and reverse peristalsis is the mechanism which produces the commonest type of intussusception (Types I and II). Opinion as to the cause of the spasm varies widely. Usually, it is assumed to be irritation of the jejunum by some unsuitable element in the diet or by the presence of the acid gastric contents, especially in the so-called "dumping stomachs." Other possible causes of the spasm which have been suggested are the gastrospasm produced by an injection of morphine (which occurred in two cases of morphine addiction)[2]; in one case trauma appeared to be a factor, and in one case a perforated jejunal diverticulum may have been a factor.[11] Some authors [2] suggest the following predisposing factors to the production of intussusception: pregnancy; different types of adhesions; a thick, contracted mesocolon, and gastrospasm through fixation of the stomal end of the jejunum. One author stresses the widening of the upper part of the jejunum which gradually takes place after a gastroenterostomy operation.

The mechanism of the so-called "combined invagination" (Type III) is probably quite different. Here, a gastrospasm or a reduction in pressure due to vomiting is presumably the primary factor, while the intussusception itself is a more secondary, passive prolapse of the loop of jejunum.[2] Undoubtedly, the reason that these intussusceptions (all three types) are not commoner is that a number of factors must operate simultaneously in order to produce them. Furthermore, it is possible that a relatively large number of the chronic type are reduced spontaneously and are never diagnosed.

Mortality.—Cases of acute intussusception have been uniformly fatal when surgical exploration was not attempted.[15] The mortality rate is given as 10% for cases in which operation was undertaken within 48 hours after the onset of symptoms, and more than 50% for operations delayed more than 48 hours.[2] These figures again stress the importance of early diagnosis and surgical treatment.

Treatment.—The only treatment for acute retrograde jejunogastric intussusception is immediate surgery. The intussuscepted loop should be reduced when possible or resected. I feel that any additional corrective procedure (to prevent recurrence of intussusception) at the time of surgery, other than reduction or resection of the intussuscepted loop, is unjustified. The reasons for this viewpoint, which differs from that of some authors, are as follows:

1. The patient is usually in poor condition at the time of surgery and will not safely tolerate additional procedures.

2. The tissues are edematous, inflamed, and often mildly contused (from the surgeon's efforts at reduction), so that any procedures requiring the placing of sutures are risky. The pulling-out of sutures from edematous tissue was undoubtedly the cause of the temporal fecal fistula in Case 1.

3. Since the size of the gastroenterostomy stoma, the type of gastroenterostomy (whether antecolic or retrocolic), and the presence or absence of an enteroenterostomy below the stoma seem to have no influence whatever on the occurrence of intussusception, and since intussusception occurs after gastric resection as well as after gastroenterostomy, there seems to be no justification for altering an already functioning gastroenterostomy, for adding an enteroenterostomy, or for substituting a gastric resection for the already existing gastroenterostomy.

4. The chance for recurrence of the intussusception is slight. I could find record of only two recurrences among all the reported cases.[3]

Summary

Retrograde jejunogastric intussusception is a rare complication of gastric surgery and a rare cause of massive hematemesis. The literature is reviewed, and two additional cases are reported.

Because it is such a little-known condition, undoubtedly many cases remain undiagnosed or misdiagnosed, and so the actual incidence may be much greater than is now suspected. The condition is easily diagnosed and treated, if the possibility of its occurrence is kept in mind, with the expectation of successful results in 90% of the cases. If proper treatment, i. e., immediate surgery, is withheld, a mortality rate of 100% may be expected.

Several aids to early diagnosis are suggested.

Addendum

A colleague¶ at Sakbayeme Hospital, French Cameroun, West Africa, reports that he has recently operated on a 60-year-old African man for whom gastroenterostomy had been performed two years ago for duodenal ulcer. Retrograde jejunogastric intussusception was found at operation. The intussusception was easily reduced with resulting viability of the bowel. This third case from Sakbayeme Hospital was of Type II A. The head of the intussuscepted loop of distal (efferent) jejunum had just reached the old gastroenterostomy stoma but had not entered the lumen of the stomach.

Sakbayeme Hospital, B.P. 5, Edea.

¶ Reihmer, V. A., personal communication to the author, 1956.

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A New Method of Canalizing Tendon Sutures with Vein Grafts

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One of the main problems in tendon surgery is the difficulty with which an acceptable degree of functional ability can be obtained after tendon repair. The very fact that the reparative process presupposes the obligatory participation of surrounding connective tissue means that, invariably, adhesions will form in every case, with subsequent diminution of the gliding mechanism.

When a tendon is divided in its paratenon structure, it will try to attach itself to whatever it encounters, or to reach out and join its opposite end in a *queue de lézard* fashion. Pseudopodia-like prolongations will anchor themselves into surrounding tissue and fix the cut ends. Likewise, if the extremity of a severed tendon, not in tendon sheath, is free or "unsatisfied" (Bunnell), it will by growth reach out and form adherences, much to the detriment of the patient's functional ability.

These processes are particularly apt to occur in end-to-end repair of tendons of unequal diameters, in such procedures as tendoplasty where a quantity of fibers find themselves free and unapposed, and in every case that presents a rugged and unhealthy bed or suture line.

The gliding mechanism of a tendon differs according to whether it pulls straight or around a corner. In the former, it runs through paratenon, while in the latter through a tendon sheath. But, whatever its mode of action, a tendon will not glide through "unfavorable" tissue. The surgeon's first obligation, therefore, is to provide a smooth anastomosis lying in a well-nourished bed.

The operative technique of reconstructing an adequate canal is, therefore, of prime importance. Many methods have been tried and, with the introduction of nonirritating plastic materials, new procedures will, I am sure, be investigated. Mayer (1940) used a temporary celluloid tube, and Thatcher (1939) tried a Stainless Steel implant, around which would form a synovial-lined sheath. McKee (1945) also uses stainless metallic rings in the primary suture of flexor tendons. Experimentally, Gonzalès (1949) has tried polyethylene cuffs in tendon repairs in dogs, with good results after 40 to 50 days. Iselin (1950), however, has been disappointed with the use of this technique in man. Milgrin (1945)* has inserted flat thin sheets of Stainless Steel foil between tendon and cicatricial tissue, suturing the tendon within this artificial sheath, removable within three weeks. McKeever † has used a special cellophane screen between tendon and scar and to separate the bones in arthroplasty. As for a more biological envelope, allantoic membrane and fascia lata are commonly used by many surgeons.

Without, in the least, trying to minimize the importance of providing a smooth bed for a tendon, I would like, here, to stress the necessity of assuring a smooth line of continuity in any surgical procedure on a tendon. Both are equally vital for its viability and for its gliding mechanism.

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* Cited by Bunnell.

† Cited by Bunnell.

Recently, W. O. Lodge and I having obtained satisfactory results with the canalizing properties of segments of vein in another branch of surgery and, secondly, having observed that in reconstructive vascular surgery the grafted portion of vein does not form undue adhesions with its neighbouring structures, I had the idea of using venous envelopes around repaired tendons, each time that these left an irregular surface. Jordan (1953) reassures us that the venous graft bridging an arterial defect "is not replaced by ingrowth from surrounding tissues as occurs in other types of prostheses." The following is an example of the use of a vein "cuff" in tendon repair.

Report of a Case

A housewife was examined for "drooping" of her right big toe, two months after an injury to the dorsum of the foot. She had dropped a knife on her foot, causing a small wound for which no medical advice was sought. The wound had healed well, but ever since the accident the patient had been unable to raise her big toe and easily tore her stockings while putting them on.

Examination revealed a severed extensor hallucis longus, and operation was advised.

Through a curved longitudinal incision over the dorsum of the foot the two ends of the cut tendon were identified and liberated. However, after the devitalized ends were trimmed off, the tendon was too short to permit an end-to-end anastomosis. The proximal end was therefore lengthened by the "step-cut" method, with glided end-to-end suture. Continuity was to be restored by a final end-to-end anastomosis with the distal portion of the tendon (Fig. 2). However, as this would leave too irregular a surface, thus hindering gliding and facilitating adhesions, it was decided to envelope the site of repair in a venous "cuff." A segment of vein measuring approximately 3 cm. was easily prepared from the dorsal arch of the long saphenous vein, readily available in the flap of our opera-

Fig. 1.—Traumatic lesion of the extensor hallucis longus tendon. Note the long saphenous vein, which will provide the canalizing "cuff."

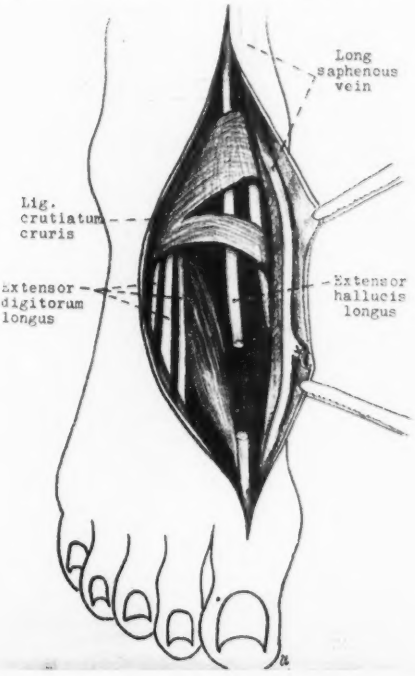
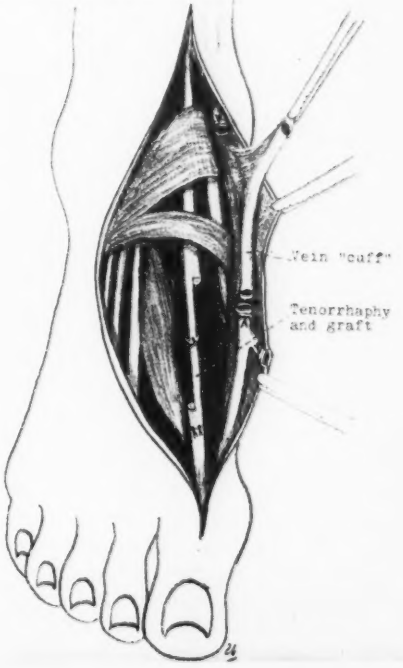


Fig. 2.—Lengthening and repair of the extensor hallucis longus. (The resulting irregular surface and free fibers would facilitate adhesions.) Preparation of the vein "cuff." (Note a step which is not shown in the illustration: The "cuff" is threaded around the tendon before the final anastomosis is established.)



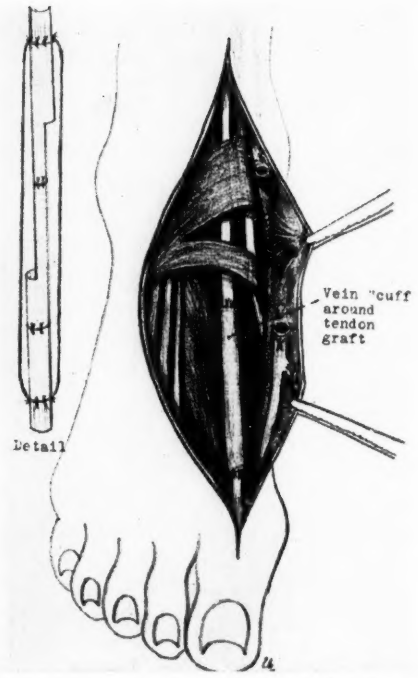


Fig. 3.—Vein "cuff" in situ, enveloping the repaired tendon and providing smooth continuity.

tive wound. This vein "cuff" was threaded up the proximal end of the lengthened tendon; the final tendon continuity was established, and the "cuff" was then slid down and made to lie over the tendoplasty site. It was held in place with two fine nonabsorbable surgical (silk) stitches at each end (Fig. 3). The skin was closed with interrupted nylon sutures, and the big toe was held in dorsiflexion with a posterior plaster splint. Gentle active mobilization was started after three weeks. During the follow-up period there were no signs of adhesive limitation, and movements of the toe are now satisfactory.

Comment

The advantages of a vein "cuff" as described above are the following: 1. They are readily available; most often a suitable "donor" vein will be found at the operative site itself, but if necessary they can easily be taken at a distance, the long saphenous vein being a very suitable source. 2. They provide a uniform, smooth, cylindrical covering, without the disadvantages of the longitudinal suture line and the unavoidable creasing of fascia lata or allantoic envelopes. 3. Over metallic and plastic tubes they present the advantage of being nonrigid. 4. Last but not least, they do not seem to incite undue ingrowth and adhesions from surrounding tissue.

By stating these advantages, it is not, however, pretended that every tendon suture-line should be covered by some foreign or venous material, nor is it intended to minimize the advantages of providing a well-nourished bed for the tendon. I would only stress that a smooth tendon surface is equally important for final good results, and where such a regular surface is lacking a vein "cuff" such as I have described can be used to advantage. It goes without saying that all the other established rules of surgery should be respected and that the "cuff" should not be too long, in order not to interfere with the blood supply.

Summary

A new method of canalizing repaired tendons is described. Where the operation involves such procedures as grafting, elongation, interlacing, or other techniques which leave irregular surfaces and free tendon ends, adhesions, and therefore failure, are to be particularly guarded against. Whenever a tendon repair is rugged, the use of a vein "cuff" to provide smooth continuity is advocated. The technique is described and the advantages are enumerated. An illustrative case is reported.

Dr. P. Zurbuchen provided the drawings.

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Chronic Duodenal Ileus Due to Chronic Arteriomesenteric Occlusion

Report of a Case

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Chronic duodenal ileus due to chronic arteriomesenteric occlusion is relatively uncommon. But it does occur more frequently than one usually thinks. Accurate evaluation of the history and clinical findings, together with the cooperation of the internist, roentgenologist, and surgeon are essential to lead to the proper diagnosis.

The patient is a 40-year-old white woman, admitted to the hospital with the chief complaints of cramping pain in the lower epigastric region and also in the right lower abdomen, associated with nausea and vomiting, of 24 hours' duration.

Further questioning revealed that the patient had seven previous operations. The first one was done 13 years ago, consisting of an appendectomy. Two months later, she had a pelvic operation, of which she was unable to give the exact nature. Then about a year later, the patient started bleeding vaginally; dilatation and curettage three times did not stop the bleeding, and she was operated upon again, at which time a subtotal hysterectomy with left oophorectomy was performed. In the following two years, the patient lost about 20 lb.; then cramping pain in the abdomen, with nausea, bile-containing vomiting, and constipation developed. A laparotomy was performed with the preoperative diagnosis of intestinal obstruction. The laparotomy consisted of release of adhesions. Since then and up to two years prior to the present admission, she had been operated upon three more times for intestinal obstruction; all the procedures consisted of "release of adhesions." All the above operations were done by the same osteopath, except the second for intestinal obstruction. The patient also stated that she had lost about 90 lb. in the past 10 years, from 180 down to 90, in a gradual manner. Furthermore, her chief complaints before the last four operations were the same; cramping pain in the abdomen, nausea, bile-containing vomiting, and constipation for two to three days during each attack. Those symptoms are the same chief complaints of her present admission. The patient stated that vomiting always relieved her symptoms.

Past history and family history are essentially negative.

Physical examination done at the time of admission, March 26, 1955, revealed an emaciated white woman, slightly dehydrated, appearing to be the stated age, in moderate distress. Palpation of the abdomen revealed slight tenderness in the lower epigastric region and in the right lower quadrant on deep palpation, with no rigidity or muscular guarding. The right kidney was palpable bimanually. Auscultation revealed that the bowel sounds were within normal limits. Otherwise, the findings were negative.

Barium-meal examination revealed a dilated duodenum and stomach, with typical pendulum movements observed in the duodenum, which consisted of peristaltic and antiperistaltic movements. There was definitely marked change of caliber of the lumen of the bowel at the duodenojejunal junction. The three-hour plate showed most of the barium was in the dilated stomach and duodenum. There was also definite evidence of widening of the duodenal valvulae conniventes and at the duodenojejunal junction, and the normal cross hatching of the mucosal plicae was changed to longitudinal rugae.

The above radiological findings, together with her clinical history, seemed compatible with a chronic duodenal ileus due to chronic arteriomesenteric occlusion. An upright flat plate of the abdomen was taken about 48 hours after the barium-meal examination, and it revealed the following findings: The head of the barium column was reaching the splenic angle of the colon, and both the splenic and the hepatic flexures were at about the level of the crests of the ileum. The cecum was low in position, below the crest of the ileum, and the entire colon was in the pelvis.

The patient was prepared by decompression with Wangensteen suction for four days, with correction of her fluid-electrolyte balance, then was explored through an upper midline approach.

Exploration revealed definite evidence of marked change in caliber of the lumen at the duodeno-

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jejunal junction, and definite pressure, due to traction of the root of the mesentery and the superior mesenteric artery, was felt. The entire small bowel was traced from the duodeno-jejunal junction to the ileocecal region, and no evidence of obstruction was found. However, plication of the entire terminal ileum was present. This plication was of a spontaneous nature and was not disturbed.

An anterocolic gastrojejunostomy with a two-finger stoma was performed. After operation, the patient was put under continuous Wangensteen suction for three days, then given simple liquids from the fourth postoperative day. The patient had uneventful postoperative evolution and was discharged from the hospital on the ninth postoperative day in good condition.

Three weeks later, the patient returned to the clinic for postoperative check-up. She was free of all symptoms, and for the first time in 10 years of her life she has gained 18 lb. Another barium-meal examination was made on that day, which revealed a well-functioning stoma and relief of the stasis of the stomach and the duodenum, as shown on the one-hour plate.

Comment

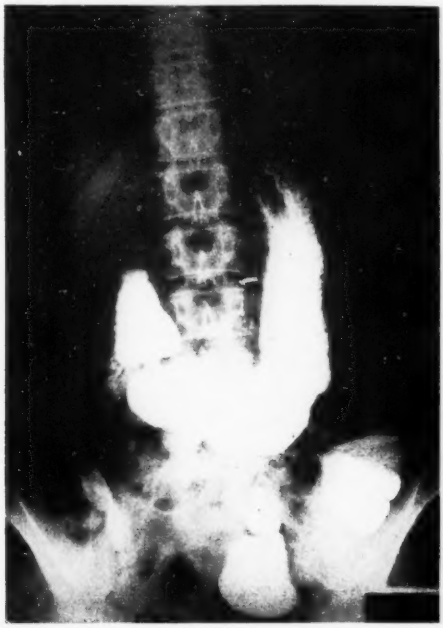
Chronic duodenal ileus due to chronic arteriomesenteric occlusion is a rare condition, due to the pressure of the superior mesenteric vessels and the mesenteric roots. Any factor which lessens the angle between the superior mesenteric artery and the aorta and/or any undue traction on the mesentery will tend toward duodenal occlusion.

Chronic duodenal ileus is usually classified into two main categories, namely, nonobstructive and obstructive, respectively.

1. *Nonobstructive Type.* — The nonobstructive type consists primarily of dilation of the duodenum, not depending on organic obstructions. There are two schools of thought regarding its etiology, namely, congenital abnormality and result of neuromuscular incoordination allied to Hirschsprung's disease. Patients who exhibit this condition present a hyposthenic habitus, with no alteration of the mucosal pattern of the duodenum.

Fig. 1.—Showing a dilated duodenum and stomach. Note the definite change of caliber at the duodenojejunal junction and widening of the duodenal valvulae conniventes.

Fig. 2.—Three-hour plate, showing most of the barium was still in the dilated stomach and C-loop.



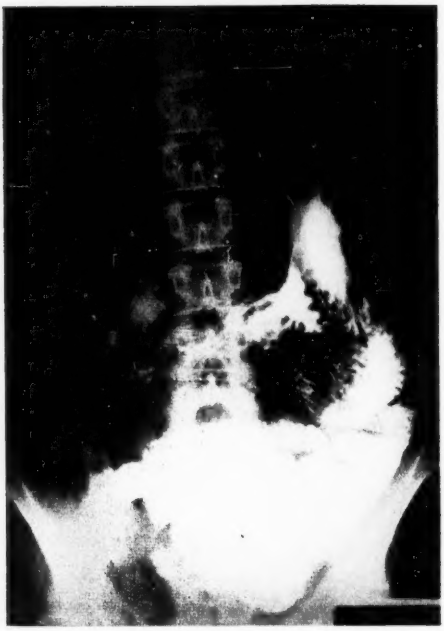


Fig. 3.—One-hour plate of the postoperative radiographs, showing a well-functioning stoma and relief of the stasis of the stomach and the C-loop.

2. *Obstructive Type.* — An obstructive ileus may be caused from intrinsic lesions, which is very rare, or from extrinsic lesions, as due to chronic arteriomesenteric occlusion, periduodenitis, congenital or acquired adhesions or bands, or from pressure caused by tumor mass, like neoplasm, cyst, or abscess of the pancreas. Among the above-stated etiologies, chronic arteriomesenteric occlusion appears to be the most frequent and most important etiology.

Chronic arteriomesenteric occlusion may be due to congenital abnormality, and it explains those cases occurring in childhood. But the condition usually occurs in adult life; thus another factor must take effect, some traction on the mesentery and one which will account for the intermittent nature of the symptoms. Enteroptosis provides this effect in two ways: the drag of the bowel on the mesentery, and by similar traction of the right colon on the mesentery when the colon is unduly mobile and dependent and the cecum ptosed in to the pelvis. In rare cases an abnormal right colic artery is the offering vessel, descending almost vertically across the duodenum.

The symptomatology of chronic arteriomesenteric occlusion is suggestive. The history of bilious attacks in visceroptotic type of female patient, gradually getting worse after the age of thirty, epigastric discomfort and flatulence following all meals and being relieved by lying down, or especially in the genupectoral position. The bilious attacks typically consist of a day of headache, nausea, and epigastric discomfort, followed by vomiting, at first clear and later bilious. Following this, the symptoms are relieved. Constipation usually occurs in the attacks, which tend to recur every month or so.

The radiological features are typical and interesting. All degrees between an apparent normal duodenum and gross dilatation may occur. Mild cases need no treatment and are not detectable apart from attacks. In an established case, the typical picture is as follows: duodenum dilated, valvulae conniventes persist, but thin and widely spaced in gross cases, which is due to the stretching of the mucosa between the valvulae and is not seen in congenital dilatation of the duodenum. Duodenal peristalsis is active, at least at first, and often presents reverse peristalsis, giving "to-and-fro" or "pendulum movements" to duodenal contents, which is quite characteristic of duodenal obstruction. It will be seen that there is no sign of annular constriction, but the bowel is flattened against the spine, its lumen being reduced to a vertical slit. At first, the characteristic feature is the appearance of the mucosal pattern; frequently in these cases the normal cross hatching of the plicae changes at the point of obstruction to longitudinal rugae.

A patient with an established case of chronic duodenal ileus by chronic arteriomesenteric occlusion should always be managed by medical treatment first. The so-called rest cure, with a long rest in bed, massage, and forced feedings sometimes so increases the deposit of mesenteric fat and

the tone of the abdominal wall as to eliminate the effect of visceroptosis in compressing the terminal duodenum. Regulation of the diet may alleviate some of the symptoms. However, if the status is marked and due to definite mechanical causes or resistant to medical management, surgical intervention is indicated.

The surgical management of chronic duodenal ileus should be, of course, dependent upon the etiology of the ileus. It can be classified into two main categories in the case of chronic arteriomesenteric occlusion.

1. If there is a definite evidence of chronic arteriomesenteric occlusion causing the ileus, a short-circuiting procedure should be performed. A gastrojejunostomy or a duodenojejunostomy will relieve the condition.

2. If there is no evidence of chronic arteriomesenteric occlusion or any other evidence of extrinsic or intrinsic factors causing the ileus, the etiology is very likely to be due to a neuromuscular incoordination allied with the Hirschsprung's disease, or "idiopathic" in nature; then a Devine's operation should be performed.

According to Devine, if duodenal stasis is due to abnormal impulses coming through the gastric sympathetics, a communication made between the duodenum and the jejunum or between the stomach and the jejunum is of no particular benefit. He advises dividing the stomach and then performing a gastrojejunostomy. Devine regards this operation as accomplishing a complete division of the sympathetic nerve supply to the pyloric portion of the stomach and the upper part of the duodenum. Devine's operation itself consists of the division of the stomach at the junction of the middle and distal thirds of the stomach, the closure of the distal stump, and a gastrojejunostomy.

Regarding the surgical management of chronic duodenal ileus due to chronic arteriomesenteric occlusion, certain authors prefer a gastrojejunostomy, and others prefer a duodenojejunostomy instead. As chronic duodenal ileus does occur not infrequently following gastrojejunostomy done for other purposes, duodenojejunostomy appears to be a better operation than gastrojejunostomy, in spite of the fact that a gastrojejunostomy was done in the above-reported case.

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Adrenal Cyst with Extensive Intracystic Hemorrhage

Observations on Criteria for Clinical and Pathological Diagnosis

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Adrenal cysts are apparently rare; a recent report of 4 instances by Adderley, Grime, and Whitehead[1] has brought the number of published cases to 81. According to these authors, most such cysts are clinically silent, being found incidentally at autopsy or operation for other diseases. Occasionally, some cause pain or present signs of an abdominal tumor as an indication for exploratory laparotomy. While clinical evidence of hemorrhage into such a cyst has been occasionally encountered, massive bleeding of proportions reported here is not common.

The present report, therefore, deals primarily with such a case of massive intracystic hemorrhage, and with the clinical criteria which should make the observer give serious consideration to the possibility of an adrenal cyst. The pathological characteristics of the specimen in this case, as well as of two additional adrenal cysts incidentally found at autopsy, are also presented as examples of stages through which this lesion may progress to become clinically significant. One of the latter has been previously described by Zuckner.[2] The two reports cited above contain bibliographies of previously reported cases of adrenal cyst.

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From the Divisions of Surgery and Laboratories, The Jewish Hospital, and the Department of Surgery, Washington University School of Medicine.

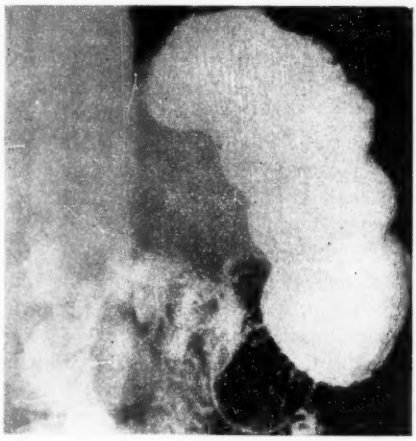

Fig. 1.—Roentgenogram from GI series, showing displacement of stomach and duodenum so that they lie completely to the left of the vertebral column.

Fig. 2.—Roentgenogram from gall-bladder series. Dotted lines outline position of the gall bladder, which is to the left of the vertebral column.

Report of a Case

A 22-year-old white woman who had delivered a normal baby six months prior to this admission had been in good health until the night preceding entry into the hospital. During that night, she was awakened by a severe pain in the right upper quadrant radiating to the back; there were no other significant complaints. A physician was called the following morning, when she was not in any great pain and was lying apparently comfortably in bed. Examination revealed no abnormality except for some tenderness in the right upper quadrant and pain on percussion over the right costovertebral angle. Pelvic examination was noncontributory. She was admitted to the hospital because the physician was unable to determine the cause of her discomfort, and by 6 p.m. of the day of admission most of the tenderness in the abdomen and back had disappeared. That night she slept well without sedation. Laboratory examinations revealed normal urine and serum amylase levels but a routine hematological work-up showed a red cell count that fell from 4,500,000 to 2,000,000 per cubic millimeter in 24 hours and a decline in hemoglobin from 11 to 7.8 gm. per 100 cc. during the same period. It was obvious that the patient had experienced a marked hemorrhage, although external evidence of this condition was minimal.

An upright plate of the abdomen revealed the right diaphragm to be pushed upward; the liver appeared somewhat enlarged, and the stomach was displaced to the left (Fig. 1). A gall-bladder series showed the gall bladder also displaced to the left of the midline (Fig. 2). The gastrointestinal series revealed nothing abnormal, but an intravenous pyelogram demonstrated flattening of the pelvis of the right kidney at its upper pole with displacement inferiorly (Fig. 3). The latter findings were thought to be due to anterior pressure.

Fig. 3.—Roentgenogram from IV pyelogram, showing flattening of the pelvis of the right kidney at its upper pole, with displacement inferiorly.

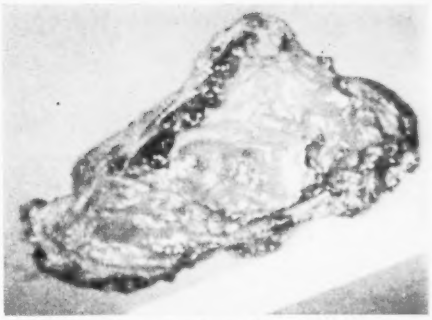

Fig. 4.—Gross specimen from principal case, showing collapsed cyst. Dark zone at upper margin represents inner lining showing through defect resulting from strip of tissue left along the great vessels.

The patient was given 2 units of blood, following which the red cell count returned almost to normal. She ate well, felt well, and walked about freely. There were no masses palpable in the abdomen. The decision to perform an exploratory laparotomy was based upon the unexplained hemorrhage and the possible recurrence of such an episode.

Surgical Procedure.—Because the possibility of an adrenal cyst was not considered, the exploratory laparotomy was carried out through an anterior abdominal approach. Upon opening the abdomen, the liver was found normal in appearance as was the gall bladder, athough both were displaced to the left. Posterior to the liver, and retroperitoneal, a dark cystic mass could be seen and palpated, extending from the superior border of the kidney along the parietal wall to the under surface of the diaphragm and along the great vessels. The posterior peritoneum was opened, and with blunt dissection the lower pole was dissected from the border of the liver; at the latter site a yellow flattened plate of tissue was identified as adrenal gland. The cyst was opened, and an estimated 2 liters of clotted blood was removed. Dissection was then carried along the wall of the abdomen and the under surface of the diaphragm. A small strip of cyst wall about 0.5 cm. wide by 5 cm. long was left along the great vessels. A drain was inserted into the space, since retroperitonealization was not possible. A routine closure was then carried out, and the patient made an uneventful recovery without evidence of adrenal insufficiency.

Fig. 5.—Small cyst filled with hemorrhage from second case; this was discovered incidentally at autopsy.

Pathological Findings.—The gross specimen from the foregoing case consisted of an irregular, flat mass of tissue, with two sides measuring 10 cm. and the two others 16 and 14 cm. (Fig. 4). One surface was reddish-brown and showed an attachment of organizing thrombus, while the other surface showed small vessels near which there were several small yellow nodules averaging 3 mm. in diameter and resembling adrenal cortical tissue. There were also two small chalk-white nodules each measuring 2 mm. in diameter. Fibroareolar tissue was attached to the specimen over many areas.

On microscopic section the capsule of the cyst was composed of hyalinizing fibrous tissue. On the inner surface of the wall there were blood clots of varying ages, ranging from recent hemorrhage to areas showing organization consisting of ingrowth of fibroblasts and proliferating capillaries. Hemosiderin in macrophages was seen in some of the latter foci. The hyaline capsule blended with adrenal cortical cells where the latter remained intact, attached to the outer surface of the cyst wall. The small yellow nodules described on the surface of the gross specimen corresponded with well-formed islands of adrenal cortical cells arranged in cords resembling zona fasciculata. In elastic-Van Gieson stains the inner wall of the cyst appeared to be continuous with the central vein, but no adrenal medulla could be identified, and only a few elastic filaments of the central vein were seen (Fig. 6).

The foregoing specimen was compared with an adrenal cyst previously reported from this laboratory by Zuckner,[2] a specimen which measured 21×17×11.5 cm. While the latter was comparable in size and microscopic characteristics with the foregoing case, it contained 2000 cc. of thin, clear, yellow fluid and showed no evidence of hemorrhage; it was discovered incidentally at postmortem examination, the patient never having presented complaints referable to this lesion.

By contrast with Zuckner's and the present case, a third tiny cyst was also discovered incidentally at autopsy and measured only 5 mm. in diameter (Fig. 5). It was filled with clotted blood, and its wall consisted of a hyaline fibrous membrane in which elastic elements were rare (Fig. 7). The wall was completely surrounded by adrenal cortex showing the usual three zones in normal arrangement, but no adrenal medulla could be found.

Comment

The clinical features of the principal case reported here are worthy of emphasis since adrenal cyst appears to be rarely considered in a differential diagnosis of retroperitoneal

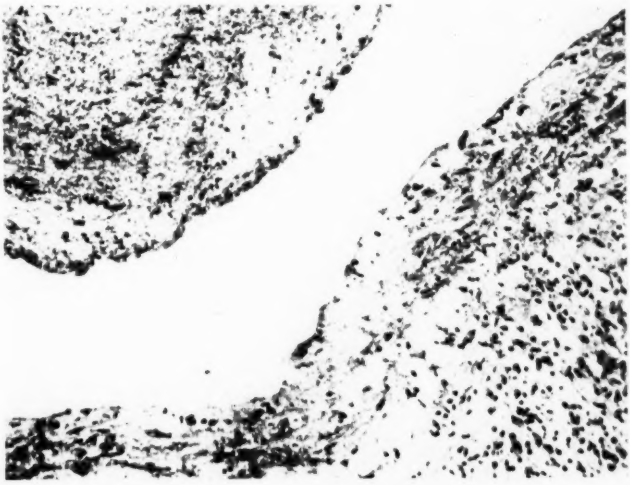

Fig. 6.—Photomicrograph of section from cyst wall of specimen shown in Figure 4. Mass at upper left is blood clot. Inner wall of cyst courses diagonally across the figure; note absence of elastic fibers. Beneath the cyst lining, along the lower right-hand margin, is an island of adrenal cortical cells. Elastic-Van Gieson stain; mag. approximately × 440.

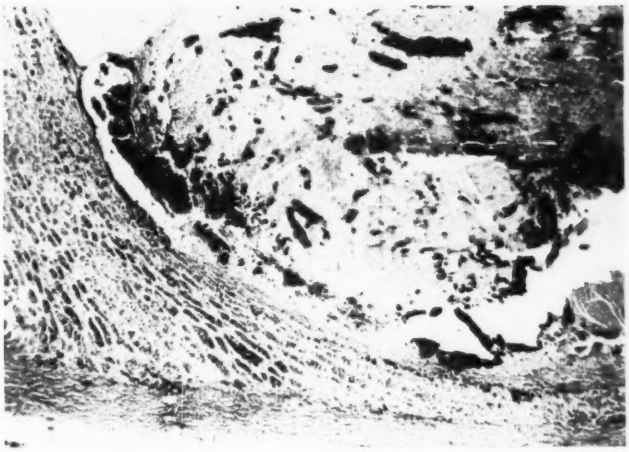

Fig. 7.—Photomicrograph of section from cyst shown in Figure 5. Fibrous adrenal capsule courses along lower margin of figure. Between the latter and cyst lining are cords of adrenal cortical cells. Note absence of elastic fibers in cyst lining. Mass in center is calcified blood clot. Elastic-Van Gieson stain; mag. approximately × 250.

masses. Solid neoplasms in this location rarely produce hemorrhage of such degree that the red cell count falls by 2,500,000 in a period of about 24 hours. It is incidentally interesting that hemorrhage into such a cyst appears not to be related to size, since the large one reported by Zuckner showed no evidence of bleeding while the tiny one last described in the previous section was filled with clotted blood. In the female subject hemorrhage into an ovarian cyst would also have to be considered, but pelvic examination could resolve this problem.

The dislocation of abdominal viscera should also lead the observer to a consideration of an adrenal cyst, although large cysts of other origin might produce a similar phenomenon. The combination, however, of an elevated liver with displacement of gall bladder and stomach would be difficult to produce by a cyst in any other location.

The third and perhaps most striking feature is the flattening of the upper portion of the renal pelvis on the side where the cyst occurs. A renal cyst or tumor might present a similar radiological picture, but these are rarely of a size to produce displacement of organs in the manner described above, and acute massive hemorrhage into a renal cyst or tumor has been an extremely rare phenomenon in our experience. It is noteworthy that a similar flattening of the upper pelvis is shown in Figure 466 (Case 3) in the report of Adderley, Grime, and Whitehead[1]; the latter case was one of an adrenal cyst measuring 18 cm. in diameter with massive hemorrhage comparable with that in the principal case in the present report.

From the standpoint of pathogenesis, it appears that not all adrenal cysts which have been reported are of similar origin. Thus, in the four cases described by Adderley, Grime, and Whitehead, one was a lymphatic cyst, one was a hemangioma, and the remaining two hemorrhagic cysts were presumably similar to those herein presented. In addition to these, as Zuckner points out,[2] some cysts have been of parasitic origin, others glandular or retention cysts, and still others cystic adenomas.

In our opinion, cysts of the type herein presented should be termed pseudocysts, since they appear to be neither cystic adenomas, glandular retention cysts, hemangiomas, lymphangiomas, nor parasitic cysts. On the contrary, if we are to judge from the smallest one in the present group, they are probably venous aneurysms originating as a maldevelopment in which the adrenal medulla may also fail to develop. However, it is not possible to exclude secondary pressure atrophy and complete obliteration of the medulla by the expanding pseudocyst. The finding of sclerotic plaques in many of these cysts, as mentioned by Zuckner, would

tend to substantiate such a vascular origin. Perhaps most significant from the standpoint of pathogenesis is the marked loss of elastic structures in the wall lining even small cysts. This may also be congenital and constitute the basis for aneurysm formation. It is particularly this type of cyst which is prone to massive hemorrhage, if one is to judge from this and previous reports.

Summary

The principal case presented in this report is of a pseudocyst of the adrenal causing (1) displacement of viscera, (2) flattening of the upper pole of the renal pelvis on the side on which the cyst occurred, and (3) hemorrhage. It is pointed out that these three phenomena together should lead the examiner to strongly suspect the presence of a pseudocyst of the adrenal in cases in which the problems of differential diagnosis of a retroperitoneal mass or of intra-abdominal hemorrhage of unknown etiology are encountered.

While there are a number of different types of adrenal cysts, it is pointed out, on the basis of the examination of two new cases and a third previously reported by Zuckner, that certain of these are probably venous aneurysms originating as a maldevelopment in which the adrenal medulla may also fail to develop. It is particularly this type which is prone to hemorrhage.

The 2 new cases in the present report bring to 83 the number of published instances of adrenal cyst.

Dr. Harold Freidman made available much of the clinical information on the principal case in this report.

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1. Adderley, C. H.; Grime, R. T., and Whitehead, R.: Adrenal Cyst, Brit. J. Surg. 42:389-394, 1955.

2. Zuckner, J.: Adrenal Cysts, Arch. Path. 50: 468-474, 1950.

An Evaluation of the Surgeon's Criteria for Determining the Viability of Muscle During Débridement

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One of the prime requisites of adequate initial surgery in war wounds is the removal of all devitalized tissue. When this is accomplished, delayed primary closure can be carried out in four to six days. On the other hand, if devitalized tissue and, especially, dead muscle are allowed to remain, bacterial growth is fostered and local infection, clostridial myositis, septicemia, and even death may ensue.

Although adequate débridement of a wound depends to a great extent on the operator's ability to distinguish viable from dead muscle, experienced surgeons differ as to the criteria of greatest reliance. Their criteria are based more on personal impressions of how wounds behave postoperatively than on any direct studies of the muscle tissue itself. Thus, although a surgeon may acquire great skill in débridement by dint of personal experience, it may be difficult for him to explain to the uninitiated the precise reasons why he has débrided in a certain way.

Four criteria are given varying degrees of emphasis by wound surgeons in judging the viability of skeletal muscle. These are color, consistency, contractility, and bleeding. This study represents an attempt to evaluate by simple clinicopathological correlation of muscle tissue the comparative validity of each of these four criteria.

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Materials and Methods

Sixty biopsies of muscle tissue of questionable viability were done by two of us (C. P. A. and Y. S.) in the course of initial débridement of twelve war wounds. The time from injury to surgery ranged from three to eight hours, with an average of six. Before biopsy the muscle tissue was graded according to color, consistency, contractility, and bleeding. Whenever possible, both surgeons corroborated in the grading. The color was recorded as dark red, red, pale, or pink. Pink was considered the color of normal, noninjured muscle. Gradations of consistency were mushy, stringy, soft, and firm. Consistency was determined by grasping the muscle with forceps and observing its character. The ability of the muscle to contract on pinching with forceps was recorded as Grade 0, 1+, 2+, or 3+. Normal muscle bleeding was rated as 3+.

The biopsy specimens, which varied from 1 to 2 cm. in diameter, were placed in saline for 20 minutes to reduce the incidence of artefacts. Then they were fixed in 10% formalin, trimmed with a sharp scalpel blade, refixed, carried through paraffin imbedding, and stained with hematoxylin and eosin. Without knowledge of the surgeons' evaluation of the muscle, the pathologist (R.E.S.) graded each microscopic section according to an estimation of the percentage of structurally damaged muscle fibers. Zero to 10% was considered none to minimal; 11% to 33%, slight; 34% to 66%, moderate; 67% to 89%, marked, and 90% to 100%, complete or almost complete damage.

Results

Microscopic Findings.—A wide variety of degenerative and necrotic changes was ob-

served in the débrided muscle. However, because of the shading of these into one another and for the sake of simplicity, the damage was graded quantitatively and not qualitatively. The least evidence of injury was separation of otherwise normal fibers from one another. Since this is a common artefact in muscle sections, it was the most difficult to evaluate and was interpreted cautiously. Fortunately, only a few specimens showed this finding. A change considered more significant was separation combined with degenerative changes in individual fibers. In its mildest form, the latter consisted of nuclear pyknosis and granular degeneration of the sarcoplasm. More advanced forms were (1) vacuolar degeneration (in which round vacuoles appeared in the sacroplasm); (2) waxy degeneration evidenced by loss of structure and deep eosinophilia of the fibers, and (3) sarcoplasmic shredding, manifested by contraction of the sarcoplasm into coarse reticular masses. These types of muscle degeneration also offered difficulties in interpretation, as some of them were occasionally present at the cut edges of otherwise normal muscle fragments. The most advanced degenerative lesions noted in the fibers were marked blurring of their internal structure, with pyknosis and disappearance of their nuclei. Fibers showing these changes were often ballooned into swollen masses comparatively widely separated from one another (Figs. 1 and 2). Moreover, the endomysial framework of such muscle was frequently disrupted, resulting in a totally disorderly arrangement of its fibers. This combination of changes undoubtedly reflects irreversible necrosis and was the most frequent form of damage observed. Other findings in the biopsy specimens were edema, neutrophilic infiltration, and hemorrhage. Their presence alone was not considered indicative of muscle degeneration. The discoid type of degeneration, which is observed in ischemic muscle, was not seen in these mechanically damaged fibers. Intravascular accumulations that could be identified with certainty as thrombi were not seen. However, it is probable that many of the intravascular red cell clumps were actually thrombotic and not postbiopsy artefacts. The vessels, especially the veins, often showed striking neutrophilic infiltration of their walls. Another finding of interest was the structural replacement of large portions of disrupted vessel walls by coagula of fibrin, platelets, and occasional red cells.

Surgical-Pathologic Correlation.—Table 1 presents the over-all correlation of surgical criteria for muscle damage with the amount of damage observed microscopically. Plotted from Table 2, the probit shows excellent

Fig. 1.—Normal undamaged muscle. Note close approximation of fibers, wavy character of myofibrils, and prominent muscle nuclei. Hematoxylin and eosin; reduced about 1/3 from mag. × 100.

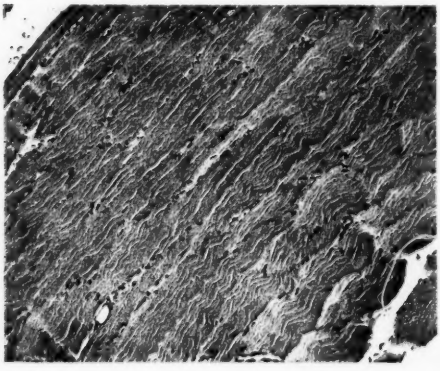
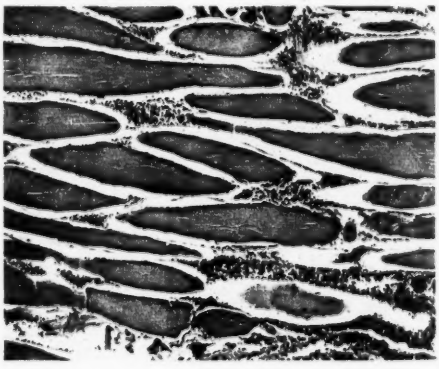


Fig. 2.—Severely damaged muscle. Note separation, swelling, and blurring of fibers, and shrinkage of their nuclei. There is hemorrhage between the fibers. Compare with Figure 1. Hematoxylin and eosin; reduced about 1/3 from mag. × 100.



linearity (Fig. 3). Thus, the population of the specimens was a statistically normal one.

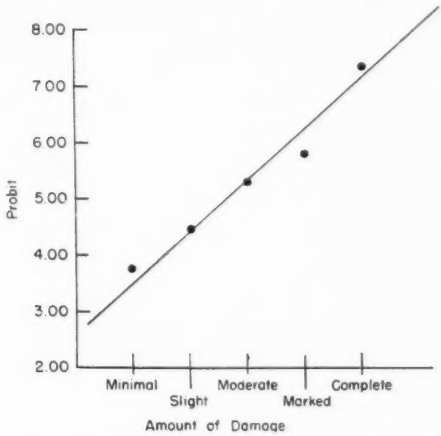


Fig. 3.—Probit line plotted from data in Table 2. The linearity shown here points out the normality of the population of specimens that were examined.

This finding adds weight to the reliability of the results.

Correlation coefficients were computed for the relationship between the various surgical criteria in each category: color, consistency, ability to bleed, contractility, and the amount of muscle damage observed microscopically. These coefficients are shown in Table 3. The best correlation between the surgical criteria and the amount of damage observed microscopically by the pathologist was found in the consistency category. However, the correlation was almost as significant in the categories of ability to bleed and contractility. Correlation between color changes and the amount of microscopic damage was doubtful from the standpoint of statistical evaluation of the data.

In general, the studies suggest that there are three valid criteria for determining the

TABLE 1.—*Correlation of Surgical Criteria with Damage Observed Microscopically*

Pathologists Impression of		Surgical Criteria															
		Color				Consistency				Ability to Bleed				Contractility*			
Degree of Damage	Number of Cases	Dark Red	Red	Pale	Pink	Mushy	Stringy	Soft	Firm	0	1+	2+	3+	0	1+	2+	3+
Minimal, 0-10%	7	2	5	0	0	1	2	0	4	2	3	0	2	4	1	1	1
Slight, 11-33%	11	5	4	1	1	0	0	7	4	3	3	5	0	7	1	2	1
Moderate, 34-66%	20	14	5	0	1	3	1	8	8	5	9	5	1	9	7	2	2
Marked, 67-89%	10	5	4	0	1	3	3	3	1	6	3	1	0	9	1	0	0
Complete, 90-100%	12	8	4	0	0	7	4	1	0	9	3	0	0	12	0	0	0
Total	60	34	22	1	3	14	10	19	17	25	21	11	3	41	10	5	4

* Degree of response: 3+, normal; 2+, less than normal; 1+, minimal; 0, none.

TABLE 2.—*Computation of Probit Line Plotted from Data in Table 1*

Degree of Damage	Number of Cases	Cumulative Cases	Cumulative %* (Σf-V_2)	Probit*
Minimal	7	7	10.8	3.762
Slight	11	18	29.1	4.450
Moderate	20	38	62.5	5.319
Marked	10	48	79.1	5.810
Complete	12	60	99.1	7.376

* From Moore, F.J.; Cramer, F.B., and Knowles, R.G.: Statistics for Medical Students and Investigators in the Clinical and Biological Sciences, Philadelphia, The Blakiston Company, 1951.

TABLE 3—*Correlation Coefficients from Analysis of Data in Table 1*

Criterion*	Correlation Coefficient† (—)	P Value
Consistency	−0.529	<.001 (very significant)
Ability to bleed	−0.418	<.001 (very significant)
Contractility	−0.353	0.01>P>.001 (significant)
Color	−0.230	—.05 (borderline)

* Number of cases, 60; number of degrees of freedom, 58.
† Computed according to Snedecor, G.W.: Statistical Methods, 4th ed., Ames, Iowa, Iowa State College Press, 1946, p. 138.

viability of muscle: consistency, ability to bleed, and contractility.

Comment

Several objections may be raised to the use of pathological observations in the evaluation of criteria for muscle viability.

1. It is possible that muscle which appears normal on routine staining with hematoxylin and eosin may actually be in an initial stage of irreversible necrosis. Moreover, muscle showing slight to moderate degrees of degeneration may be capable of restoration to normal. Despite these valid suppositions, it is logical to assume that the microscopically observed severity of muscle damage parallels in general the actual degree of degeneration and necrosis. Therefore, pathological appearances, although they may not indicate the presence or absence of viability in every instance, nevertheless are of value in grading the comparative degrees of damage in various muscles sampled and, thus, in forming a standard for evaluating the four criteria of the surgeon. For example, it appears valid to say that if a mushy consistency characterizes 17 of 22 specimens showing marked structural damage and only 3 of 18 specimens showing slight structural damage, then the appearance of this abnormal property indicates a greater degree of damage on the path to irreversibility. On the other hand, if a dark-red color does not show a similar correlation with the grade of structural damage, it is inconceivable that this property could be a better indication of muscle death than a mushy consistency. One is not justified, however, in concluding that specimens showing slight damage and a normal consistency are necessarily viable.

2. The difference in time between injury and biopsy might vitiate comparison of the structural changes in the muscle specimen of one soldier and those in the specimen of another. Fortunately, the strength of this objection is minimized by the fact that, unlike its sluggish structural response to ischemia, muscle reacts rapidly to the stimulus of mechanical injury. Thus, the time factor did not seem an important variable in comparing individual samples. Some muscle specimens taken three hours after wounding showed the same severe grades of clinical and pathological damage as those taken at eight hours.

3. A qualitative as well as a quantitative evaluation of the structural damage would give a more accurate picture of the status of the muscle. Since most of the damaged muscle showed the severest type of change, this objection is less serious than if the other types of degeneration were seen with equal frequency.

Difficulties encountered in the clinical approach include those of evaluating precisely small portions of muscle and of expressing the observed changes in objective recordable terms. Since all the grading was done by two surgeons, these difficulties were minimized as much as possible. As a corollary to the problem of accurate expression of observations, the results of this study must be interpreted by each surgeon in the light of his own personal experience.

In conclusion, although there are limitations to the interpretation of this study, it suggests that a statistically significant corre-

lation exists between consistency, ability to bleed, and contractility on the one hand and the amount of damage to skeletal muscle on the other. Change in color appears to be a less consistent and reliable criterion of muscle damage. It seems logical to conclude further that the first three properties are more valid criteria of muscle viability than the last one.

Summary and Conclusions

A clinicopathological study was carried out to evaluate the surgeon's criteria for the viability of muscle in wounds requiring débridement.

Sixty biopsy specimens of muscle were taken from war wounds three to eight hours after injury. Each portion of the muscle specimen was graded by two surgeons according to its color, consistency, ability to bleed, and contractility. The pathologist graded each specimen independently according to the amount of microscopic damage. Following this, a correlation of the surgical and pathological findings was made.

A statistically significant clinicopathological correlation was obtained for three criteria: consistency, ability to bleed, and contractility. Color appeared to be of doubtful value in determining the amount of muscle damage.

Decortication in Unresolved Tuberculous Pleurisy with Effusion and Empyema

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Introduction

Since 1946, decortication has been performed with increasing frequency on tuberculous patients. Gurd[1] and Mulvihill* were among the first to present encouraging reports about decortication. Decortication has been advocated not only to remove fibrocaseous intrapleural residuals but to improve pulmonary function.† Streptomycin has certainly made this operative procedure safer.

Our experience in treating pulmonary tuberculosis in Army Chest Centers has led us to believe that maximum drug effect in pulmonary tuberculosis takes place at about eight months of combined chemotherapy. In the past, in accordance with this clinical finding, we have decorticated patients with unresolved tuberculous pleurisy and empyema after six months to one year of drug therapy. This has been, in some instances, as late as from nine months to one and one-half years following onset of symptoms. It was felt that the procedure was safer at this time because the activity of the tuberculous process was lessened. In critically evaluating these patients, we have discovered disappointingly poor pulmonary function bronchospirometrically. Postoperatively, there has often been difficulty in getting the decorticated lung to fill the chest, and the incidence of postoperative complications has been significant.

Because of these factors, an attempt was made to select a group of patients for relatively early decortication who fulfilled the following criteria as nearly as possible:

1. Patients with relatively recent disease processes.
2. Patients who had had approximately six months of chemotherapy.
3. Patients whose constitutional symptoms were gone.
4. Patients with relatively unchanging x-rays over a two- to three-month period.

It was hoped that earlier decortication might better salvage pulmonary function before interstitial fibrosis occurred and lower the incidence of postoperative space problems. We were, however, somewhat concerned about operating in the presence of relatively short preoperative treatment with chemotherapeutic agents.

We are reporting briefly the following seven cases decorticated in succession under the above-mentioned plan of selection. Pulmonary function studies on several patients and their implications will be discussed. In no instance has there been an operative or postoperative spread of disease, postoperative complication, or mortality.

Report of Cases

CASE 1.—A 27-year-old white man admitted initially on Jan. 20, 1955, with a temperature of 104 F, tightness in the right chest, and dyspnea of three weeks' duration. He remained febrile for three weeks. On Jan. 27, 1955, a right thoracentesis was done, with removal of 1100 cc. of clear, straw-colored fluid which was reported positive for Mycobacterium tuberculosis upon culture. He was started on therapy of 1 gm. of streptomycin twice weekly and 12 gm. of PAS daily on March 2,

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From the Thoracic Surgical Service and the Pulmonary Disease Service, Valley Forge Army Hospital, Phoenixville, Pa.

* In discussion of Reference 1.

† References 2 and 3.

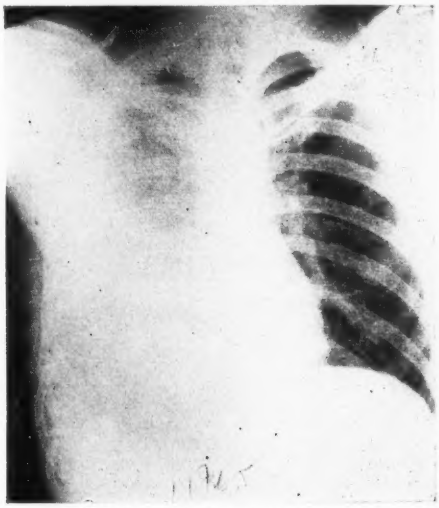


Fig. 1.—Case 1, admission film.

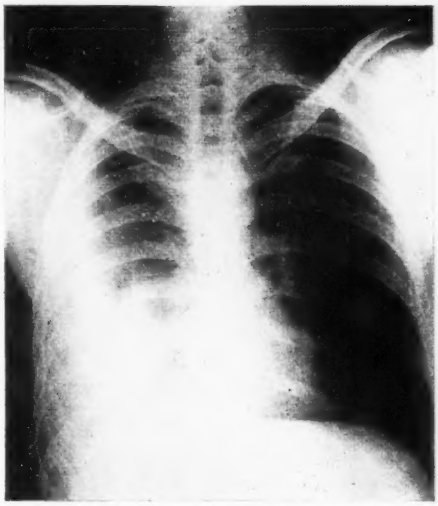


Fig. 2.—Case 1, preoperative film.

1955. Three more thoracenteses were done, but complete evacuation was not accomplished. The pleural fluid contained 99% lymphocytes. His chest roentgenograms still revealed a homogeneous density in the lower third of the right lung field. He was transferred to Valley Forge Army Hospital (Fig. 1) on March 23, 1955, and his chemotherapy was changed to 2 gm. of streptomycin I. M. every third day and 300 mg. of isoniazid (INH) daily. On June 3, 1955 (Fig. 2), because of the persistent pleural effusion, a right decortication was done, and a thick peel was removed with relative ease. Pathologically, the peel revealed dense fibrous tissue with maturing granulations along one edge and well-formed granulomas with necrotic centers, epithelioid cells, and Langhans giant cells. Inoculation of a guinea pig was done, and at autopsy typical lesions of tuberculosis were found in the lymph nodes, spleen, and liver. The patient's postoperative course was uneventful, and a chest film dated Oct. 20, 1955, (Fig. 3) revealed both lung fields to be clear and the right costophrenic angle slightly blunted. The antituberculous chemotherapy was continued until Dec. 2, 1955, giving a total of nine months.

Comment.—In this case, definite restrictive ventilatory insufficiency was seen prior to surgery, as shown by the pulmonary function studies (Fig. 4). Five months after the onset of the pleurisy, a right decortication was performed, and three months postoperatively physiological evaluation showed a return to normal of the ventilatory measurements (Fig. 5). Oxygen consumption in the decorticated lung, however, did not show any improvement (Tables 1, 2, and 3).

Case 2.—A 21-year-old white man admitted initially on Aug. 18, 1954, with the chief complaints of fever and dyspnea on exertion and motion. His temperature was 103 F, and a chest roentgenogram revealed a massive pleural effusion. He continued to be febrile, with temperatures ranging between 101 and 104 F, until Nov. 14, 1954. Three left thoracenteses were done early in the course of his

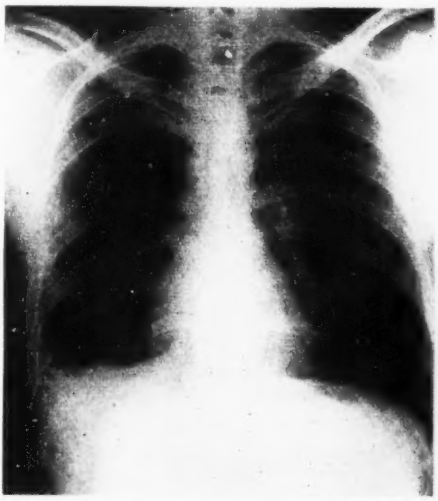


Fig. 3.—Case 1, postoperative film.

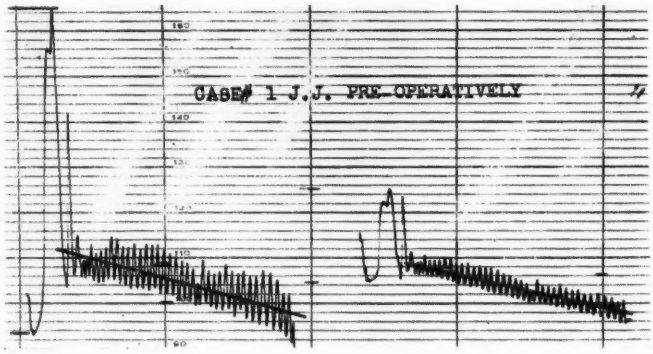


Fig. 4.—Case 1, preoperative bronchospirogram. The left tracing refers to the left lung, the right, to the right lung.

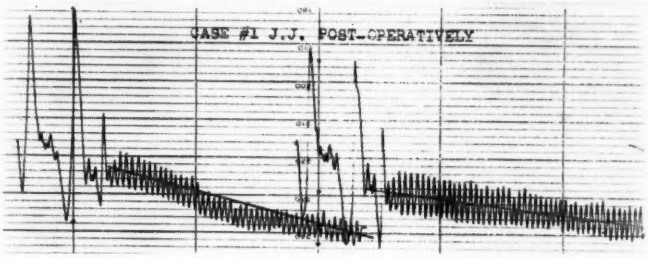


Fig. 5.—Case 1, postoperative bronchospirogram. The left tracing refers to the left lung, the right, to the right lung.

disease, and the pleural fluid was clear and straw-colored, with 99% lymphocytes. P. P. D. No. 1 was 2+. He was transferred to Valley Forge Army Hospital on Sept. 20, 1954. Repeated thoracenteses failed to completely evacuate the pleural effusion on the left, the roentgenogram (Fig. 7) still revealing a homogeneous shadow obscuring the lower half of the left lung field. The pleural fluids on Oct. 9, 20, and 21, 1954, were positive for M. tuberculosis upon culturing. On Sept. 20, 1954, therapy of 2 gm. of streptomycin every three days intramuscularly and 300 mg. of INH daily was started. On Dec. 10, 1954, because of the persistent left pleural effusion (Fig. 7) and complete subsidence of systemic manifestations, a left decortication was carried out which involved the removal of a very dense and thick peel, which was moderately adherent. The pathologic specimen revealed dense fibrous tissue in which there was abundant granulomatous inflammatory disease actively proliferating. The inflammation was characterized by large and small tubercle-like aggregates centrally showing epithelioid cells and necrosis surrounded by abundant proliferating

TABLE 1.—*Maximum Breathing Capacity, Vital Capacity, and Timed Vital Capacity*

Case		M. B. C., Liters/Min.		V. C., L.		T. V. C.*
		Observed	Per Cent†	Observed	Per Cent†	
Normal			100		100	95–100
1	Pre‡	118	87	2.7	76	75
	Post§	152	112	3.5	97	97
2	Post	149	110	4.0	93	93
3	Pre	110	70	3.0	67	90
	Post	116	75	3.8	73	100
4	Pre	102	85	2.7	63	92
	Post	125	104	2.9	68	96
7	Post	150	107	3.2	66	100

* T.V.C. is measured in per cent of vital capacity forcibly expired in 3 sec.
† Per cent of predicted normal.
‡ Pre refers to preoperative values.
§ Post refers to postoperative values.

TABLE 2.—*Bronchospirometry (Breathing Room Air)*

*Tidal Air and Oxygen Consumption**

		Case 1		Case 2	Case 3		Case 4	
		Pre	Post	Post	Pre	Post	Pre	Post
Tidal air, cc.	Total	247	393	300	241	311	455	491
	Right†	37	56	47	75	60	29	40
	Left‡	63	44	53	25	40	71	60
Oxygen consumption, cc./min.	Total	356	331	344	196	384	255	274
	Right*	30	31	58	74	53	41	30
	Left	70	69	42	26	47	59	61

* Pre refers to preoperative values; Post, to postoperative values.
† Per cent the right lung contributes.
‡ Per cent the left lung contributes.

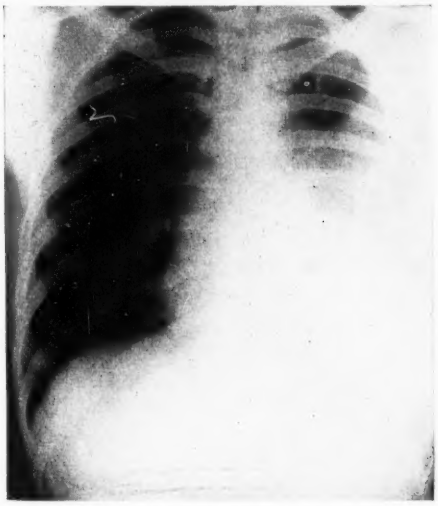


Fig. 6.—Case 2, early x-ray.

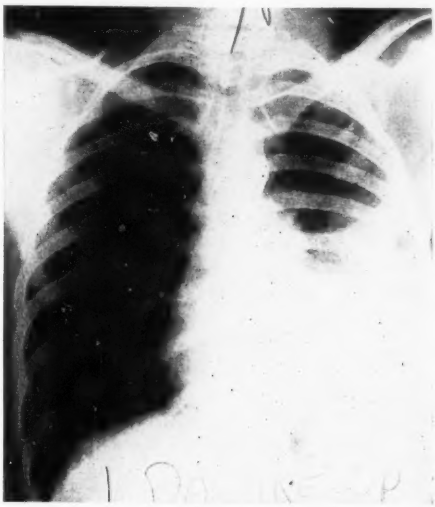


Fig. 7.—Case 2, preoperative film.

epithelioid cells, mononuclears, plasma cells, and lymphocytes. Scattered through the inflammatory tissue were numerous Langhans' giant cells. Direct smears of fresh material revealed abundant acid-fast bacilli.

Culture of the peel was positive for M. tuberculosis. Breathing exercises were carried out from Dec. 14, 1954, until Jan. 27, 1955, at which time he developed homologous serum hepatitis. All antituberculous chemotherapy was stopped, and

TABLE 3.—*Bronchospirometry (Breathing 100% Oxygen)*

*Tidal Air, Oxygen Consumption, and Per Cent of Vital Capacity**

		Case 1		Case 2	Case 3		Case 4	
		Pre	Post	Post	Pre	Post	Pre	Post
Tidal air, cc.	Total	271	361	459	144	259	418	528
	Right†	40	62	51	73	60	23	44
	Left‡	60	38	49	27	40	77	56
Oxygen consumption, cc./min.	Total	317	254	427	114	157	255	274
	Right	46	33	53	73	57	41	39
	Left	54	67	47	27	43	59	61
Vital capacity	Right	23	50	54		60	30	34
	Left	77	50	46		40	70	66

* Pre refers to preoperative values; post, to postoperative values.
† Per cent the right lung contributes.
Per cent the left lung contributes.

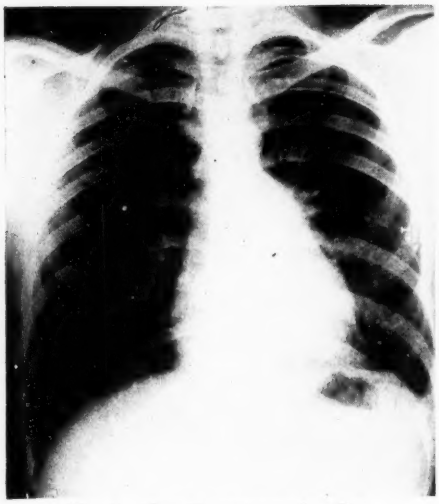


Fig. 8.—Case 2, postoperative film.

INH alone was started again on Sept. 19, 1955, and continued until Dec. 3, 1955, for a total of seven months. Chest x-rays from Jan. 29, 1955, on have been clear, and the patient has been asymptomatic (Fig. 8).

Comment.—Preoperatively, this patient revealed, upon fluoroscopic examination, marked restriction of the left lung. A decortication of the left lung was performed four months after the onset of the pleurisy. Eleven months after the surgery was accomplished, pulmonary function studies revealed the ventilatory and oxygen consumption measurements to approximate normal averages (Tables 1, 2, and 3).

This patient, both on x-ray and at surgery, had extensive pleural pathology. It is interesting to note that his postoperative function studies are excellent, particularly since this man was decorticated only four months after the onset of his symptoms.

Case 3.—A 22-year-old white man who developed chills, fever, and generalized malaise on July 10, 1954, associated with anorexia and gradual weight loss, was admitted to the hospital on July 18, 1954. Chest roentgenograms revealed a left pleural effusion, and three thoracenteses were done, on July 19, 20, and 21, 1954, with the removal of 1250 cc. of straw-colored fluid. A guinea pig inoculated with this pleural fluid was positive for M. tuberculosis on Sept. 14, 1954. Therapy of 2 gm. of streptomycin every three days and 300 mg. of INH daily was started on July 30, 1954. He was transferred to Valley Forge Army Hospital on Sept. 27, 1954. Because of a persistent left pleural effusion, and after numerous unsuccessful thoracenteses, a left decortication was performed on Feb. 11, 1955 with relative ease, using both blunt and sharp dissection. The peel was approximately 1 in. (2.5 cm.) thick in some areas. There was no evidence of an empyema, and the peel was thick and fibrous. Pathologically, the tissue was extremely thick, dense, and fibrous, with scattered foci of granulomatous inflammation. The areas of inflammation frequently showed central caseous necrotic centers surrounded by epithelioid cells. Each of the foci was encased in broad sheets of dense, fibrous tissue. The acid-fast stains revealed rare acid-fast bacilli.

His postoperative course was uneventful, and his chemotherapy was continued until July 30, 1955, when he was discharged from the hospital on temporary retirement. By April 12, 1955, the pleural residuals were completely resolved as seen by the chest roentgenograms, and the lung fields have remained clear.

Comment.—Marked restrictive insufficiency and decreased oxygen consumption were seen preoperatively in this case. Seven months after the onset of the pleurisy, a left decortication was performed, and six months postoperatively, physiologic evaluation revealed definite improvement in the ventilatory function and in oxygen consumption (Tables 1, 2, and 3).

It is interesting to note that although the decortication was not done until seven months after the onset, unusually good results were obtained in both ventilation and oxygen consumption.

Case 4.—A 31-year-old white man who was admitted initially on July 7, 1955, with paraumbilical distress between meals relieved by food and antacids. He had a past history of a peptic ulcer proved roentgenologically. A chest roentgenogram revealed a right pleural effusion, and further questioning brought forth a history of dyspnea on exertion and increasing fatigability since January, 1955. For four months prior to admission, he experienced intermittent, sharp, right subscapular chest pain. For the past six months, he noted evening temperature elevations. On July 15, 1955, a thoracentesis was performed through the right posterior subscapular area, with removal of 100 cc. of clear, straw-colored fluid. He was transferred to Valley Forge Army Hospital on July 22, 1955. P. P. D. No. 1 was positive. He was placed on therapy of 2 gm. of streptomycin every three days I. M. and 300 mg. of INH daily on July 28, 1955.

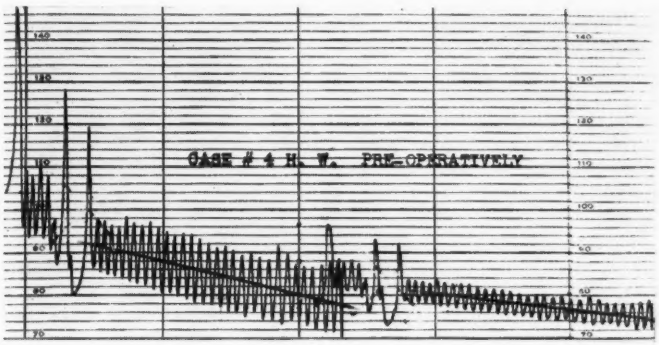


Fig. 9.—Case 4, preoperative spirogram. The left tracing refers to the left lung, the right, to the right lung.

On. Sept. 30, 1955, because of a persistent, loculated pleural effusion, a right decortication was performed, with the removal of a 1 cm. thick, leathery peel over the lower two-thirds of the right lung. The peel was moderately adherent to the lung, but a good cleavage plane was present between the peel and the chest wall. The texture of the lung was rather soft and boggy, without the normal elastic feel. The lung expanded fairly well to fill the chest. Pathologically, the sections were composed of relatively acellular dense collagenous tissue. Acid-fast and Gridley stains were negative. Chemotherapy was continued to a completion of six months postoperatively. He has remained asymptomatic, and his chest roentgenograms have remained negative for intrapulmonary pathology.

Comment.—This case revealed definite restrictive ventilatory insufficiency prior to surgery (Fig. 9). Nine months after the onset of his symptoms, a decortication was performed on the right lung, and three months postoperatively physiologic evaluation (Fig. 10) revealed a return of the ventilatory studies to more normal values. Oxygen consumption remained abnormal with respect to distribution, and the values were low (Tables 1, 2, and 3).

Case 5.—A 21-year-old white man who was well until February, 1954, at which time he developed left anterior chest pain. An x-ray of the chest at this time was reported as negative. On June 17, 1954, he developed a cough and anorexia and started to lose weight. He was hospitalized on June 24, 1954, and a left thoracentesis was done, with the removal of 700 cc. of amber-colored fluid and 150 cc. several days later. He was transferred to Valley Forge Army Hospital on Aug. 24, 1954, and 2 gm. of streptomycin every three days and 300 mg. of INH daily were continued, their having been initially administered on June 24, 1954. On Dec. 8, 1954, because of the persistent left pleural effusion, a left decortication was done with relative ease. Pathologically, the sections consisted of dense fibrous tissue, much of which was of the hyalin type. Within the fibrous tissue, there was a confluent chronic granulomatous inflammatory process. The granulomatous inflammation took the form of a tuberculous reaction, with abundant epithelioid proliferation and areas of caseous necrosis. Langhans' giant cells were

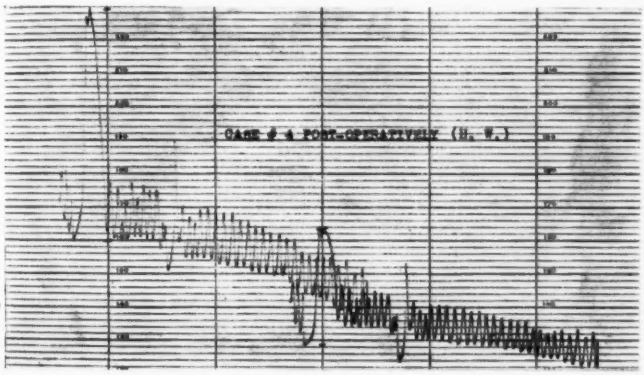


Fig. 10.—Case 4, postoperative spirogram. The left tracing refers to the left lung, the right, to the right lung.

abundant. Acid-fast stains revealed rare acid-fast bacilli. Culture of the decortication specimen was positive for M. tuberculosis.

Chemotherapy was continued until July 8, 1955, for a total of 12 months. Post-thoracotomy roentgenograms of Dec. 8, 1954, showed resection of the left sixth rib, with a homogeneous haze throughout the right hemothorax. The January, 1955, chest roentgenogram revealed the pleural residuals to have resolved completely, and the lungs were negative for any intrapulmonary pathology. Postoperatively, the patient had an uneventful course and has remained asymptomatic.

Comment.—Pulmonary function studies were not done on this patient. Clinically, however, marked restriction of movement of the left lung was seen preoperatively on fluoroscopic examination. A left decortication was done 10 months after the onset of symptoms, and three months postoperatively fluoroscopic study revealed approximately 90% return of motion of the left lung and diaphragm.

Case 6.—This 18-year-old white youth developed a slight productive cough in June, 1954, and increasing malaise led to his admission to the 46th Mobile Stations Hospital in Korea on July 19, 1954, where he was found to have a 75% pneumothorax on the left. Following aspiration and reexpansion, he developed a fever with temperature to 104 F and became "shocky." On July 21, 1954, catheter drainage was started. On July 25, 1954, he was transferred to Tokyo Army Hospital, and there he was found to have a positive sputum for M. tuberculosis. Pleural fluid was also positive for M. tuberculosis. He was transferred to Valley Forge Army Hospital on Oct. 18, 1954. Therapy of 2 gm. of streptomycin every three days I. M. and 300 mg. of INH daily was started on Aug. 7, 1954, and continued until Aug. 15, 1955. On Nov. 15, 1954, this patient had a superior segmental resection of the left lower lobe and a left decortication done. The pathological specimen revealed caseous lesions surrounded in part by epithelioid cells and in part by fibrous tissue. There were scattered compactly arranged tubercles. Acid-fast smears were positive for M. tuberculosis, and the culture was positive. Postoperative roentgenograms by Dec. 6, 1954, revealed resolution of the pleural residuals and complete reexpansion of the left lung. The chest films remained clear and free of any lesions up to his discharge, on Oct. 5, 1955. His postoperative course was uneventful, and he has remained asymptomatic.

Comment.—Evaluation of pulmonary function in this patient was determined on a clinical basis. Fluoroscopically, there was marked restriction of motion of the left lung prior to the left decortication and segmental resection, which was performed five months after the onset of symptoms. Three months postoperatively, fluoroscopic examination revealed approximately 90% return of movement of the left lung.

Case 7.—A 22-year-old white man noted malaise and lethargy in April, 1954. Later, he developed left anterior-lateral chest pain (sharp in nature), aggravated by deep inspirations and motion, dry

Fig. 11.—Case 7, early chest x-ray.

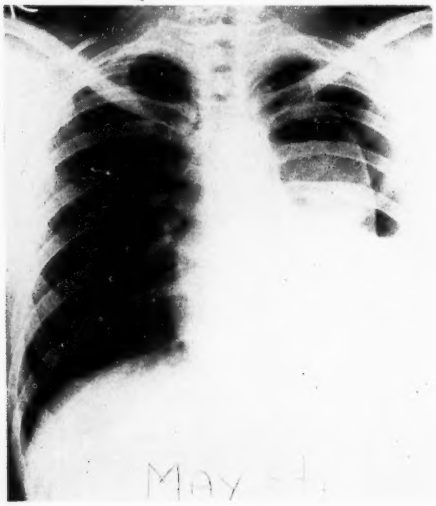
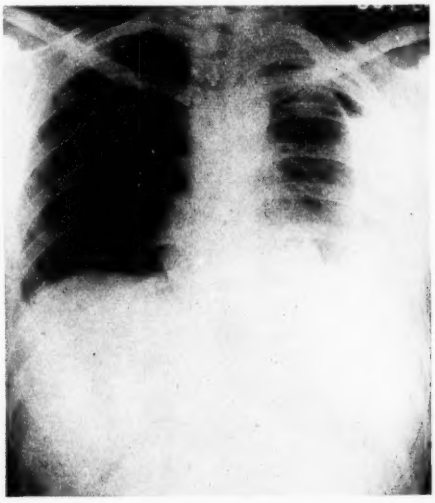


Fig. 12.—Case 7, preoperative film.

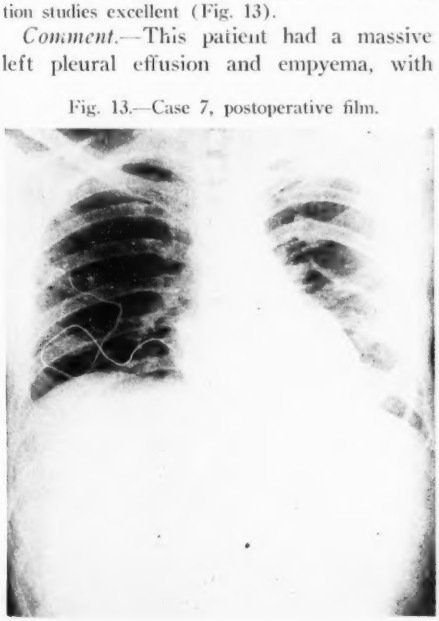


cough, low-grade fever, and night sweats. In early May, 1954, he developed a fever with temperature of 103 F, and he was hospitalized in Korea, where a massive left pleural effusion was found on chest roentgenogram (Fig. 11) and for which two left thoracenteses were done. He was transferred to Valley Forge Army Hospital on June 23, 1954, where several thoracenteses were done, resulting in very small amounts of fluid being removed at any one time, and a persistent homogeneous shadow was seen in the lower two-thirds of the left lung field. On July 13, 1954, M. tuberculosis organisms were found on culture of the pleural fluid. On Oct. 13, 1954, because of the persistent left pleural effusion (Fig. 12), a left decortication was performed with considerable ease. Pathologic examination revealed dense hyalinized tissue through which were scattered a few tubercles. There was abundant caseous material seen. Smear and culture of the peel were positive for M. tuberculosis. The patient's postoperative course was uneventful, and a chest roentgenogram dated Dec. 12, 1954, revealed both lung fields to be clear. Therapy with 2 gm. of streptomycin every three days I. M. and 300 mg. of INH daily had been started on June 1, 1954, and was continued to March 6, 1955, at which time he was transferred to a Veterans' Administration Hospital, where his chemotherapy was to be continued.

On Jan. 10, 1956, he was examined in the outpatient department and found to be asymptomatic. His chest roentgenogram was clear and his function studies excellent (Fig. 13).

Comment.—This patient had a massive left pleural effusion and empyema, with complete restriction of motion of his left lung, fluoroscopically, prior to a decortication, which was accomplished six months after the onset of symptoms. Two months postoperatively, approximately 95% of motion of the left lung was seen fluoroscopically.

Fig. 13.—Case 7, postoperative film.



Ventilatory studies were done on this man 15 months postoperatively. The observed maximum breathing capacity was 150 liters/minute, with a predicted 140 liters/minute. His total vital capacity was 3.15 liters, being just 66% of the predicted. His timed vital capacity in three seconds was 100% (Table 1).

These studies illustrate an excellent return of the ventilatory function.

Comment

It is apparent from a study of these case problems that pulmonary function has been definitely improved clinically as well as by measurement, particularly as far as ventilation of the decorticated lung is concerned. We note, however, that oxygen uptake is not improved uniformly. We have had no instance of operative spread. It has, indeed, been difficult to select cases for early decortication, inasmuch as a decision has to be made concerning which patients will respond spontaneously, assisted by aspiration and other therapeutic measures, and which patients will not resolve with these measures. However, in the cases selected herein, massive pleural pathology was invariably found. We have been surprised at the amount of caseous material and thickened pleural peel present which was totally unapparent to us through preoperative x-ray examination.

Summary

A series of seven patients undergoing relatively early decortication for unresolved tuberculous pleuritis with effusion and empyema is reported. Postoperative complications have been found insignificant, and ventilatory function has been found to be much improved. We have been disappointed as far as improvement in oxygen uptake in

the decorticated lung is concerned. This suggests that even earlier decortication might seem indicated to better preserve this lung function.

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Editorials

THE ANESTHESIOLOGY CENTRE OF COPENHAGEN

AT HAND is a brief report of the fifth year's activities of the Anesthesiology Centre in Copenhagen.[1] Many of the experiences and results are of considerable interest to surgeons in this country where, despite much progress, there are still shortages in trained medical personnel in this field. But the report has an even wider bearing on the medical aspects of international relations.

The tardy development of anesthesiology as a specialty was not due to the failure of an early start. It is stated,[2] for example, that John Snow, who received his M.D. from the University of London in 1844, specialized in anesthesia as soon as the news of John Collins Warren's demonstration came from America in 1846. He served as anesthetist in St. George's Hospital in London, making several contributions to the methods then in use. It was remarkable, therefore, that for nearly a century, in this country at least, physicians shunned the field and even surgeons disdained any interest in anesthesia and tended to relegate its performance to the youngest, the most inexperienced, and the least expert members of the surgical staff or, in many cases, to the patient's general practitioner. It is to the great credit of nurse technicians trained for the administration of anesthesia that they remedied this bad situation and successfully bridged an important period in the history of anesthesia. In this country, at least, they carried on until it finally became appreciated that more than simple technical excellence is required of the anesthetist.

The Anesthesiology Centre in Copenhagen was started in 1950 under the auspices of the World Health Organization. Its regional director, Dr. Norman D. Begg, emphasized, however, that "the role of WHO must always be a secondary one." Nevertheless, he recalled that "the interest of International Organizations was aroused initially by requests from some of the most war-damaged countries to introduce the surgical technics from which they had been excluded by the scientific blackouts of the world wars." Thus, in 1948, the WHO (in association with the Unitarian Service Committee) introduced anesthesiology into Poland as a part of the demonstration of modern trends by a team of visiting physicians from many countries. The present author was a member of this team and saw at first hand the beneficial impact of this program. An American physician anesthesiologist, Dr. Meyer Saklad, was a member of this team for the full two-month period. Other anesthetists from England, Sweden, and Switzerland served for shorter intervals. By 1949, Dr. Begg goes on to state, the interest in Europe toward the introduction of anesthesiology as a separate discipline grew rapidly. A national training center was established in Prague, and this led to the opening of the present training center in Copenhagen on May 1, 1950. This was really the first major project in anesthesia supported by WHO. Later on, centers were established in Paris, Formosa, and Yugoslavia.

The Anesthesiology Centre in Copenhagen is under the directorship of the eminent and esteemed yet modest and personable Dr. Erik Husfeldt, Professor of Surgery of the University of Copenhagen. Its function is the training of doctors of medicine from all over the world in the art and science of anesthesiol-

ogy. The trainees come from Norway to Mozambique, from Germany to India. Fellowships are available. Applicants must have had at least two years of experience in their field before taking the course.

The course in anesthesiology is an interesting combination of practical and didactic teaching. The course is given in five Copenhagen hospitals in which a total of 30,000 anesthetics are given each year, thus providing ample clinical material. Examinations are held at frequent intervals. Morbidity and mortality meetings are held once a week. The wide scope of the didactic program is illustrated by lectures given in such fields as neurophysiology, psychiatry, epidemiology, physiotherapy, radiology, and cardiology, in addition, of course, to surgery, internal medicine, physiology, pathology, and anatomy.

All classes are held in English. While most of the instructors are Danish, several are from the United Kingdom and the U. S. A. All together, 35 instructors from these latter two countries have spent some time giving lectures and supervising clinical work. From our country, Drs. Ralph Waters and Stewart Cullen were among the first, followed later by Dr. Robert Dripps and his associates from the University of Pennsylvania and many others.

One of the tributes to the effectiveness of this training center is the fact that only 7 out of the total of 129 trainees have left the specialty, and 31 are now in charge of and heading departments of anesthesia in various parts of the world. It was one of the most pleasant experiences of the author during the meeting of the International Society of Surgery in Copenhagen July, 1955, to visit one of these anesthesia centers and to see at first hand the vast amount of work being done and the excellence of the teaching program. Of special interest was the important role of the nurses. In the hospital I visited, the chief anesthesiologist insisted that it would be impossible to carry out their program without the help of specially trained nurses. It was my impression, however, that these nurses were not trained as independent anesthetists, but rather as nurse technicians similar perhaps to the operating room nurses in this country.

This international school of anesthesiology is not only a striking example of what can be achieved in promoting understanding between nations but is also a demonstration that high standards in an important field can be set up and maintained on an international basis. Many surgeons and physicians in this country are learning to appreciate the good which can flow from international exchanges of this kind. In this respect, the problems of anesthesiology are not unique. When physicians of different countries get together they soon realize that other fields in medicine also know no political or geographic boundaries. Such a pattern for world-wide understanding, if extended more and more to other groups, could be an important step to universal peace.

ROBERT ELMAN, M.D.

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IMPORTANT SIDE-ISSUES IN THE TREATMENT OF CARDIOSPASM

IN THE category of esophageal disease there reside several interesting clinical entities. Considerable progress has been made in recent years towards a better understanding of the esophagus. Surgeons are probing this area on a broad plane. Usually, such interest is the forerunner of important accomplishments to come. Following the pattern so commonly observed in medicine, the development of a proper therapeutic approach has preceded the development of equivalent information concerning etiology. It should be pointed out that in treatment, the most important guide to optimum therapy has been based upon a knowledge of the etiology of the disease.

One of the fascinating diseases of the esophagus is cardiospasm. As a perpetrator of illness adversely affecting society, it has gathered various aliases, viz., achalasia, megaesophagus, phrenospasm, esophagospasm, etc. The disease itself is a concise clinical entity, but with incompletely understood anatomic and physiologic abnormalities. Characteristically, there is spasm of the lower esophagus and cardia, delayed passage and retention of food, and dilatation of the proximal esophagus. A psychosomatic overlay is observed in many patients. Although the etiology is unknown, one theory suggesting autonomic imbalance seems the most acceptable. In the absence of any organic lesion distal to the dilated esophagus, the assumption that a disordered neuromuscular mechanism is at fault appears to be a reasonable one. It is important to emphasize that there exists no natural tendency to cure; furthermore, neither drugs nor other medical measures ameliorate the patient's symptoms nor affect the course of the disease. If neglected, in time, the disease progresses to a fatal termination.

This brief introduction brings us immediately face to face with problems in treatment. Bouginage and hydrostatic dilatation have been persisted in for decades; that the results are imperfect has been well documented. Supposedly, by bouginage 10% of patients enjoy complete temporary relief of all symptoms. Perhaps, 5% will remain well for prolonged periods; however, repeated dilatations are necessary. Hydrostatic dilatation, either once or upon repeated usage, presumably brings relief to 75% of all patients. The remainder have been considered surgical candidates.

The time has come for surgeons to question the reputedly excellent results obtained by these measures. Some physicians are easily satisfied with lesser procedures and an incomplete result. A severely symptomatic patient likewise may be uncritical of a procedure which reduces the intensity of symptoms but does not produce an asymptomatic state. It would appear that the benefit which accompanies dilatation of any type must be due to the partial or complete rupture of the muscular layers in the area of spasm. In a sense, then, these methods represent a means of performing blind and uncontrolled operations. On occasion, they terminate in severe complications and death. Possibly, we have outgrown these lesser procedures in the management of cardiospasm.

The popularity of and persistence in the use of such procedures often can be traced to inadequacies in the alternative procedures offered. Thus, some introspection into the surgeons' offerings may be in order. First of all, admittedly, many surgical procedures have been tried and found wanting for various reasons. Too frequently, the patient has traded cardiospasm for reflux esophagitis. This has been the major fault of operations designed to obviate the obstructive factor in cardiospasm. We have maintained that in any operative procedure which

destroys, by incision or excision, the sphincteric mechanism at the esophagogastric junction with restoration of gastrointestinal continuity by esophagogastrostomy, regurgitation is an almost constant sequela, and, at the same time, have stressed the fact that esophagitis is a secondary phenomenon.

By increments the surgeon has matured considerably as newer data have shed additional light on these problems. The possible surgical approaches have grown in number and have incorporated niceties which should obviate the patent disadvantages of some of the earlier operations. In my opinion, there are three procedures which possess merit. (1) The Heller operation (1913), which in current practice consists of an anterior cardiomyotomy through the area of spasm (Zaaiger modification). (2) Excision of the spastic area with the "entire" acid-secreting area of the stomach with reconstruction by esophagoantral anastomosis plus a pyloromyotomy. An incidental vagotomy is performed also (Wangensteen, 1950). (3) Sphincter substitution by an interposed jejunal segment between the esophagus and stomach combined with bilateral vagotomy and Finney-type pyloroplasty (Merendino, 1955).

If one agrees that direct vision surgery should supersede the blind approach, the modified Heller operation would appear to be the procedure of choice in early cases. It is a relatively simple operation, and sufficiently good results, particularly in Great Britain and on the Continent, have been reported to justify its re-evaluation. At the same time, many surgeons, the editorialist included, have observed poor results. A significant number of patients will exhibit regurgitation; however, surgeons who have had considerable experience indicate that symptomatic regurgitation of a serious nature has been observed in relatively few cases. It should be pointed out that reflux esophagitis usually develops over a period of years. It is difficult in our present state of information to predict its incidence and severity in patients with asymptomatic regurgitation.

If this deficiency exists, how can one condone the use of this procedure, particularly in view of our previously expressed opinion concerning the relationship of regurgitation and esophagitis when the sphincter is inactivated? I do so mainly because I believe the Heller-Zaaiger procedure can be further improved. If reflux esophagitis is responsible for the majority of poor results, would it not be rational to incorporate into the Heller operation bilateral vagotomy together with a Finney-type pyloroplasty? Unpublished experimental data from this laboratory indicate that under severe histamine stimulation esophagitis following the Heller-Zaaiger operation is markedly reduced and almost nonexistent by the addition of these two items. While some morbidity accompanies this combination, the advantages appear to outweigh the disadvantages by far.

Both of the remaining operative approaches have taken cognizance of the importance of the acid-peptic factor after excision of the "sphincteric" mechanism. In one, the major portion of the acid-peptic secretory epithelium has been excised; the other has separated the acid-bearing portion of the stomach from the esophagus by a jejunal segment which behaves as a physiologic sphincter. The vagotomy and pyloroplasty have been incorporated to protect not the esophagus but the more resistant jejunum from digestive damage. While these two procedures have been used with success in a modest number of patients with primary cardiospasm and cardiospasm with complications, perhaps, at the moment, they are best reserved for complicated or advanced cases pending further trial.

This editorial has evolved by the process of "thinking out loud." Complete agreement of the reader was neither anticipated nor sought. In fact, disagreement has been engendered willfully by the manner of its presentation. If disagreement has occurred, or if renewed interest has been stimulated by this approach, my objective has been fulfilled. Again, it should be emphasized that the etiology and the pathophysiology of cardiospasm remain an enigma. The medical world awaits a comprehensive classical effort on the "sphincter" and its control; only then may we be enlightened and in essential agreement concerning the proper management; only then may disrupted friendships be restored.

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Case Reports

ANNULAR PANCREAS, COMMON-DUCT COMPRESSION, AND CHOLELITHIASIS

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AN ANNULAR pancreas may produce symptoms over a wide span of years, ranging from the early neonatal period to late in life. When I reviewed the literature concerning this unusual malformation in 1952,[8] only 70 cases had been reported and the majority of the patients were adults. Only 19% of these patients were in their first year of life. However, 47 new cases have been reported since 1952, and a rather remarkable reversal of age incidence has occurred. Of the 47 new patients, 33 have been infants (70%). It is also of interest to note that, while adult cases continue to appear in the literature as reports of single cases, infant cases are now being reported in series of 5, 6, and 10 cases.*

Duodenal obstruction, peptic ulceration of the stomach or duodenum, pancreatitis, and common-bile-duct obstruction are the major clinical disturbances which may result from the presence of an annular pancreas. Of these, duodenal obstruction is by far the commonest. In my initial report, the suspicion was expressed that jaundice from common-duct obstruction might be anticipated in a significant number of the infants with symptoms due to annular pancreas. Jaundice had been observed in three † of the seven neonatal cases reported up to that time and in two ‡ of five patients studied later in infancy. However, this fear has proved to be unfounded on the basis of the findings in the infant cases reported since 1952. Common-duct obstruction with jaundice was found in only 1 [12] of these 33 infants.

Evidence suggesting common-duct compression and interference with biliary-tract function has been encountered in only three of the reported adult cases of annular pancreas.§ For this reason, it has seemed desirable to report an adult case of annular pancreas in which both cholelithiasis and common-duct compression were found.

Report of a Case

The patient, a 73-year-old white married carpenter, was admitted to the hospital March 26, 1956, because of intermittent symptoms of nausea and right upper quadrant abdominal pain, with suspected cholelithiasis of three months' duration. He had not experienced food intolerance and had never been jaundiced.

There was no family history of congenital malformations. The patient had been healthy all his life, except for an episode of colonic carcinoma in 1949, and had been working steadily up to the time of his admission to the hospital. In 1949, he had had unexplained weight loss of 35 lb. with no other symptoms. Roentgenograms after a barium enema had revealed a carcinoma of the ascending colon, and a right colectomy had been carried out by my father, Dr. Will C. Moore. The patient has remained free of symptoms with no evidence of recurrence for the past seven years.

Cholecystograms were obtained with oral administration of iopanoic acid (Telepaque) a short time prior to admission to the hospital, and only faint visualization of the gall bladder was observed. There was a question concerning the possible presence of a single gallstone in the gall-bladder area. Roentgen studies revealed the upper gastrointestinal tract to be within normal limits. There was no evidence of duodenal obstruction. The barium enema study showed evidence of a previous

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From the Surgical Service, Ball Memorial Hospital, Muncie, Ind., and the Department of Surgery, Indiana University School of Medicine, Indianapolis.

* References 4, 6, and 11.

† References 3, 8, and 9.

‡ References 5 and 10.

§ References 1, 2, and 13.

right colectomy. The anastomosis functioned well, and there was no suggestion of tumor recurrence.

The findings on physical examination were essentially within normal limits. There was some mild tenderness on deep palpation in the right upper quadrant. The urine examination gave normal results. The hemoglobin was 17.5 gm. per 100 cc.; the red blood cell count was 5,700,000 and the white blood cell count 5900 per cu. mm. The patient's prothrombin time was 100%, and his nonprotein nitrogen was 23 mg. per 100 cc. The serum bilirubin determination showed a total concentration of 0.6 mg. per 100 cc. The sulfobromophthalein (Bromsulphalein) test revealed 4% retention of the dye at 30 minutes and no retention at 45 minutes.

The patient was taken to the operating room on March 26, 1956. The peritoneal cavity was entered by means of a right subcostal incision. The gall bladder was found to be distended and tense. However, there was no evidence of acute inflammation. A single gallstone could be palpated within the gall bladder. During removal of the gall bladder, the common bile duct was observed to be markedly distended. Although stones could not be palpated within the common duct, exploration was felt to be necessary because of its significant increase in size. When the common duct was opened, bile escaped as though under some increase in pressure. No stones could be found on careful probing of the ducts with stone scoops. However, even the smallest Bakes dilator could not be inserted into the duodenum. The ampulla of Vater could not be identified because of a fullness in the region of the second portion of the duodenum. It was decided that the duodenum should be mobilized to permit more satisfactory manipulation in the area of the ampulla of Vater. When the lateral peritoneal attachment of the second portion of the duodenum was divided, it was found that the fullness in the area was due to the presence of an annular pancreas (Fig. 1). This presumably was responsible for the common-bile-duct enlargement and the difficulty in inserting a dilator through the sphincter of Oddi into the duodenum. The pancreatic ring was approximately 3 cm. wide and completely encircled the duodenum at the level of the ampulla of Vater. There was no evidence of duodenal obstruction. The duodenal lumen through the annulus seemed to be quite adequate. With the duodenum mobilized and by means of bimanual manipulation, the smallest Bakes dilator available, the No. 2 size, finally was passed into the duodenum and was identified distal to the annular pancreas. The sphincter area was dilated to allow passage of a No. 5 Bakes dilator. It could not be dilated beyond this point. A T-tube was inserted into the common duct at the choledochotomy site to maintain biliary-tract decompression following operation. An exploratory "second look" at the peritoneal cavity failed to reveal evidence of recurrence of the colonic carcinoma which had been managed by resection seven years earlier. The incision was closed in layers with interrupted nonabsorbable surgical (silk) sutures, and the patient was returned to the ward in good condition.

When the excised gall bladder was opened, a single gallstone was found (Fig. 2). Mucosal cholesterosis and muscular hypertrophy of the

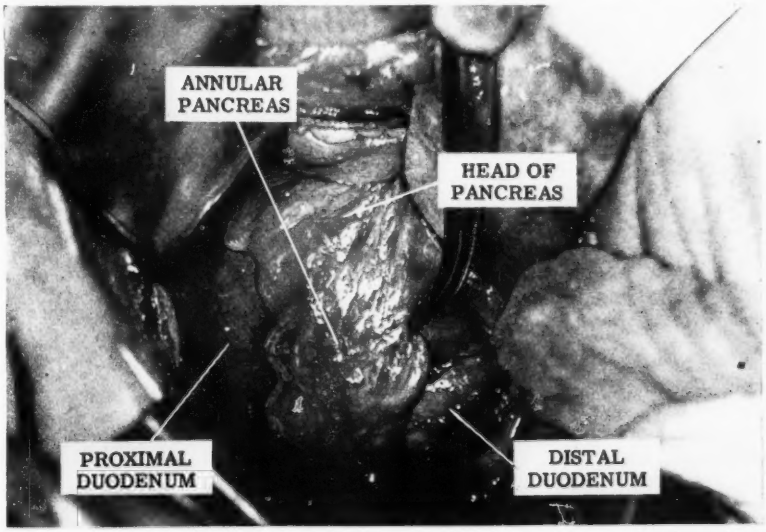

Fig. 1.—Photograph showing the appearance of the annular pancreas at the time of operation.

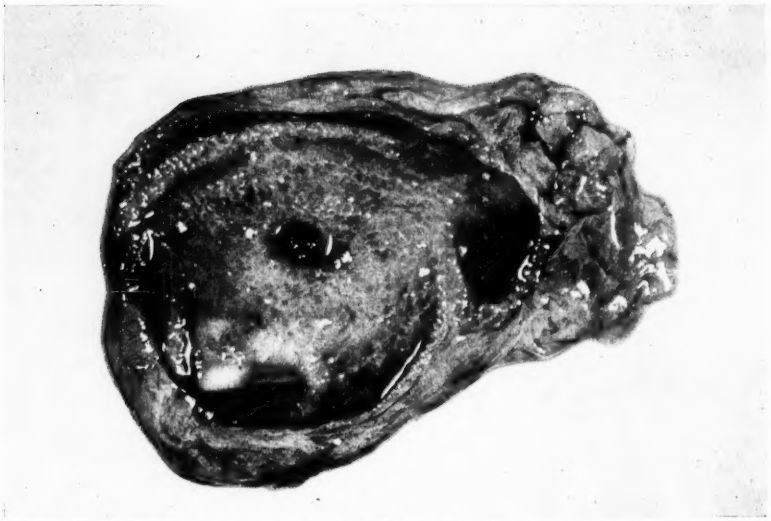

Fig. 2.—Photograph of the excised gall bladder demonstrating the gallstone, the mucosal cholesterosis, and the muscular hypertrophy in the region of the neck of the gall bladder.

neck of the gall bladder were also noted. Chronic cholecystitis was observed on microscopic examination.

The postoperative course was rather uneventful, and recovery was prompt. There was a slight elevation of the serum bilirubin to 2.6 mg. per 100 cc. three days following operation. In two more days, the serum bilirubin had returned to essentially normal levels. Cholangiograms were made by the injection of radiopaque media through the T-tube 11 and 14 days after operation, and both studies showed some residual compression of the common duct at its terminus in the area of the ampulla of Vater (Fig. 3). The patient was dis-

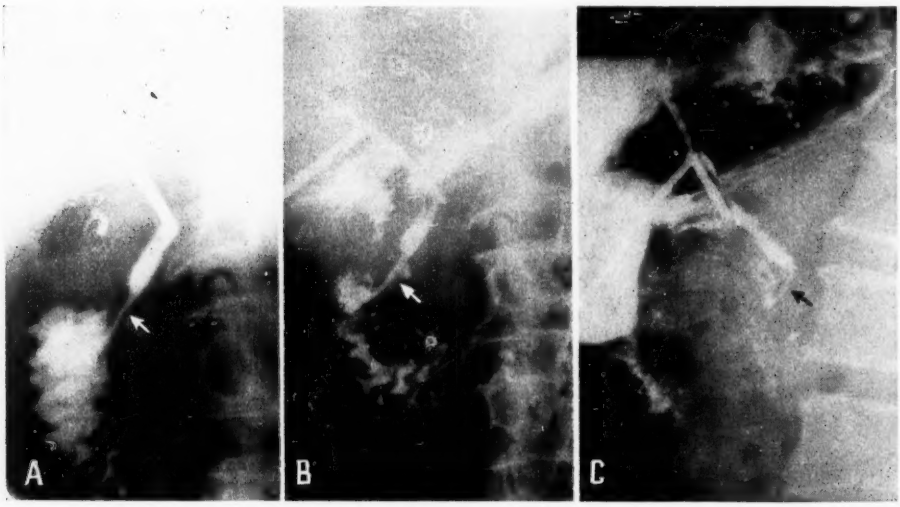

Fig. 3.—Cholangiograms obtained by the injection of radiopaque material through the T-tube 11 days (*A*) and 14 days (*B* and *C*) after operation. Some residual common-duct compression is shown in all films (arrows). Cholangiography only was carried out in *A*. In *B* and *C*, the roentgen findings from the simultaneous use of T-tube cholangiography and upper gastrointestinal barium study are presented in anteroposterior and lateral views.

charged from the hospital on April 11. The T-tube was removed on April 30, and the patient has continued to do well since that time.

Comment

The annular pancreas in this patient had remained essentially asymptomatic throughout 73 years of life. At no time had there been a suggestion either of duodenal or of common-bile-duct obstruction. The clinical and roentgen findings prior to operation were regarded as evidence of chronic cholecystitis and cholelithiasis. If the marked increase in size of the common duct had not stimulated further exploration of this segment of the biliary tract and the ampullary outlet into the duodenum, the annular pancreas in all likelihood would have remained undiscovered. The annular pancreas, however, was identified when the inability to pass even the smallest probe into the duodenum through the opened common duct led to mobilization of the duodenum, a mobilization which was initially carried out in order to achieve more effective bimanual manipulation of the exploring instruments in the ampullary area. The significant increase in the size of the common bile duct and the resistance in the ampullary area to the passage of probing instruments were regarded as evidence of at least partial common-duct obstruction or compression. The incomplete nature of the obstruction was indicated by the freedom of the patient from jaundice and the normal preoperative serum bilirubin determination. For these reasons, simple dilatation of the ampullary area and temporary common-duct decompression by means of a T-tube were regarded as preferable to division and reimplantation of the common duct.

It is intriguing to speculate on the possible role of annular pancreas in some cases in increasing the likelihood of gall-bladder dysfunction and cholelithiasis. The 27-year-old woman studied by Zech [13] was shown on cholecystography to have a rather large gall bladder which concentrated the radiopaque medium poorly. This gall bladder did not empty after a fatty meal, and its function was regarded as impaired. Although the patient reported on by McNaught [7] was jaundiced, no evidence of common-bile-duct obstruction could be found on postmortem examination. Death was regarded as due to chronic alcoholism and toxic hepatitis. This patient's gall bladder had been removed a few years earlier because of cholelithiasis. Cholecystectomy for cholelithiasis also had been carried out in the case of Brown, Bingham, and Cronk [2] a few weeks prior to their initial examination of the patient. Their patient was mildly jaundiced, with a serum bilirubin level of 2.4 mg. per 100 cc. Common-duct obstruction by a stone was not found at operation and could not be shown later on autopsy.

The potential capability of an annular pancreas to cause common-duct obstruction and jaundice is well illustrated by the case of Anderson and Wapshaw.[1] Their patient, a 32-year-old woman, had had recurrent episodes of abdominal pain, vomiting, and jaundice. The gall bladder could not be visualized on cholecystography 10 days after the jaundice had cleared. At operation, the gall-bladder wall was thickened, but no stones could be demonstrated. The pancreas in the area of the annulus was nodular and firm, suggesting the presence of chronic pancreatitis. The common bile duct was considerably dilated and free of stones. When it was opened, a sound could be passed into the duodenum without hindrance. Resection of a segment of the pancreatic annulus was performed in the hope of relieving any pressure on the common duct which might have existed. However, cholangiography 14 days following operation showed the common bile duct to be abnormally dilated, with a partial obstruction in the ampullary area. This finding suggests that division of the pancreatic annulus is as unsuitable as a means of relieving the biliary-tract obstruction which may accompany this malformation as it is in relieving duodenal obstruction when it occurs. Residual obstruction and the oc-

currence of pancreatic fistulae have all too frequently followed efforts to divide or resect a portion of the pancreatic annulus.

Summary

A case of annular pancreas with common-bile-duct compression and cholelithiasis occurring in a 73-year-old man is reported. There had been no history of jaundice. The patient was managed by cholecystectomy and transcholedochal dilatation of the constricted area, followed by temporary biliary-tract decompression with a T-tube. Although postoperative cholangiograms demonstrated some residual compression of the common duct, the patient has recovered satisfactorily and has remained free of symptoms. The literature concerning biliary-tract obstruction accompanying annular pancreas is discussed.

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SITUS INVERSUS ABDOMINALIS AND CHRONIC CALCULOUS CHOLECYSTITIS

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SITUS inversus is a relatively rare condition but one which presents a number of practical considerations to the surgeon. Blegen reports that in mass chest x-ray surveys this anomaly will probably be found once in every 6000 to 8000 persons.[1] In United States Army recruits the incidence was 1 in 35,000.[8] Tanner-Cain and Crump reported an incidence of 1 in 17,000.[8] There are probably more than 15,000 persons in the United States with this situation.[3] The transposition is not total in all instances, but may be limited to the thoracic or the abdominal viscera. Partial situs inversus is far more infrequent than the total variety, and surgical abdominal problems may present a greater diagnostic challenge when the heart is in the left hemithorax.

Situs inversus is of clinical significance because other congenital anomalies are commoner with visceral transposition than in the general population and because of the diagnostic problems presented by the seemingly bizarre manifestations of acute abdominal episodes when the abnormality is not recognized. This communication reports a case of situs inversus abdominalis with chronic cholecystitis, cholelithiasis, and choledocholithiasis.

Report of Case

A 28-year-old white woman was admitted to the Montefiore Hospital by Dr. Harold Rifkin on June 20, 1955, complaining of belching and epigastric pains radiating to the shoulders after ingestion of cabbage or fried foods for the previous year and a half. There was no history of biliary colic or obstructive jaundice. The past history was significant in that the patient had known since childhood that she had a transposition of her abdominal viscera and that her heart was on the proper side. She had rheumatic fever at the age of 8, without cardiac symptoms. Two and a half years before the present admission she had had infectious mononucleosis followed by hepatitis and jaundice, necessitating hospitalization for one month. On examination she was a 5 ft. 1 in., 116 lb. woman in no acute distress. The heart was on the left side and of normal size; there was a short blowing systolic murmur at the apex. The abdomen revealed no masses or tenderness. The remainder of the examination was unremarkable.

The complete blood cell count and urinalysis were within normal limits. The serum bilirubin was 0.7 mg. per 100 cc., and the electrocardiogram was normal. Roentgen examination confirmed the presence of situs inversus abdominalis (Fig. 1). Oral cholecystography revealed the gall bladder to be located in the left upper quadrant and full of calculi (Fig. 2*A*).

Operation was performed on June 21, 1955 (E. S. H.). A left upper rectus muscle-splitting incision was employed, and the diagnosis of situs inversus abdominalis was confirmed on exploration of the peritoneal cavity. The gall bladder was full of calculi, and the common bile duct was enlarged to at least twice its normal size. The cystic duct was solidly impacted with calculi and inserted on the medial aspect of the common duct. A cholecystectomy and choledochotomy were performed, and six facetted small stones were removed from the common duct. A T-tube was inserted into the common duct. The left-sided appendix was then removed, and the abdomen was closed after drains had been placed to Morison's pouch and the gallbladder bed.

The postoperative course was uneventful except for a superficial wound infection which responded to drainage. A cholangiogram performed through the T-tube on the seventh postoperative day demonstrated normal patency of the common duct, with no dilatation or residual calculi (Fig. 2*B*), and the T-tube was removed on the eighth day. The surgical pathology was reported as chronic cholecystitis with cholelithiasis of the combined variety and fibrotic appendix. There have been no complaints referable to the biliary tract in the 16 months since operation.

Comment

In the absence of complicating events or anomalies, situs inversus may remain undis-

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From the Surgical Division, Montefiore Hospital.

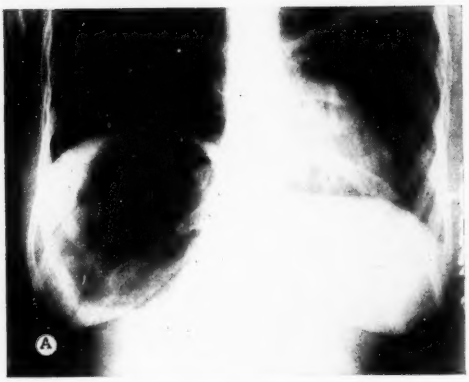
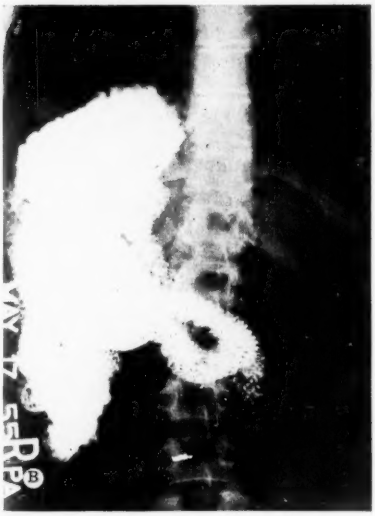


Fig. 1.—Roentgenograms showing (*A*) heart on left and gastric air bubble on right and (*B*) barium-filled stomach on right.

covered. However, when it is recognized, as in the case presented, it should be emphatically called to the attention of the patient or the parents so that this information is available to the physician treating the patient during acute abdominal episodes.

One of the most confusing factors in the diagnosis of an acute abdominal episode in the patient with situs inversus is the variability of pain localization. The location of visceral pain in situs inversus may shift from one side of the body to the other, depending on the stage of the disease. There



is considerable evidence that the central nervous system is not transposed in situs inversus totalis. Although the viscera are transposed, their nerve supply remains the same, and the pain may be referred from the diseased viscus to the somatic area supplied by the same segment of the nervous system.[9] The localization of pain may shift from the referred phenomena to direct visceral or somatic perception due to peritoneal irritation when the disease progresses. False pain projection, however, is much less common in situs inversus with gall-bladder

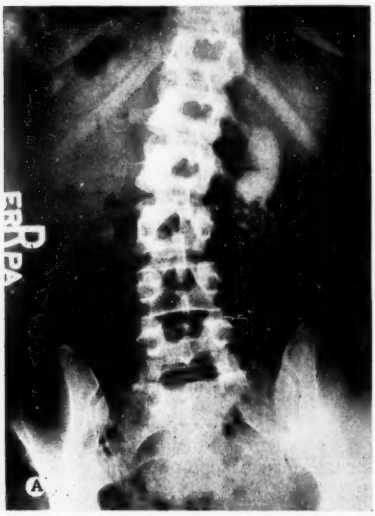
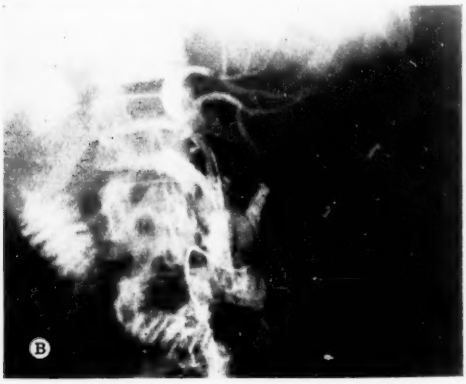


Fig. 2.—*A*, oral cholecystogram, showing multiple calculi in left-sided gallbladder. *B*, postoperative T-tube cholangiogram demonstrating normal biliary ducts in case of situs inversus.



disease (8%) than with acute appendicitis (31%).[1] The possibility of performing the incision on the wrong side of the abdomen is a real one.

The diagnosis of gall-bladder disease in persons with unsuspected situs inversus totalis or abdominalis by cholecytography can be misleading if only small x-ray films covering the right upper quadrant are used. The absence of a gall-bladder shadow may be misinterpreted as representing disease.

In general, the diagnosis of situs inversus totalis can be made more frequently by fluoroscopy than by chest x-ray. The unsuspecting interpreter of the chest x-ray is more apt to read the film as normal without checking the markers, or he may assume that the markers were incorrectly placed. This potential error is eliminated by fluoroscopy. The presence of the gastric air bubble beneath the right diaphragm on chest x-ray or fluoroscopy suggests the possibility of situs inversus abdominalis.

There is no evidence that biliary tract disease occurs more commonly in persons with situs inversus than in the general population. Blegen reviewed the literature in 1949 and reported 24 cases of situs inversus with biliary tract disease, of which 6 had common duct calculi.[1] Mayo and Rice (1949) reported seven cases, two of which were in infants who had congenital atresia of the bile ducts associated with complete situs inversus.[5] Kullander (1950) presented a case of situs inversus abdominalis with cholecystitis without cholelithiasis.[4] Shank and Stafford (1953) described a case of situs inversus totalis with cholelithiasis complicated by carcinoma of the gall bladder.[7] Acute cholecystitis with situs inversus totalis has been recorded by Munnell and Ponka.[6]

Rarely, a left-sided gall bladder may occur in the absence of situs inversus. In these cases the gall bladder lies on the undersurface of the left lobe of the liver. Twelve such instances are described in the literature, according to Bleich, Hamblin, and Martin.[2]

Summary

Cholecystectomy and choledocholithotomy were performed in a young woman with previously established situs inversus abdominalis.

The possible pitfalls associated with this anomaly are discussed.

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DUODENAL OBSTRUCTION BY AN INTRALUMINAL DIVERTICULUM

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OBSTRUCTION of the duodenum in adult life, caused by factors other than duodenal ulcer, is a rare and diagnostically intriguing situation. Partial obstruction can exist for many years, giving rise to chronic abdominal distress which is abolished with striking rapidity upon removal of the obstruction.

In the following case, the duodenal obstruction was caused by an intraluminal diverticulum. Because of the dramatic x-ray findings, the unusual pathogenesis, and the happy outcome from treatment, it provided an interesting study of this uncommon condition. We have found only one other such case reported [1] in the medical literature; that case resembled the following one in all respects.

Report of Case

The patient, a 33-year-old white man, consulted us primarily because of intermittent abdominal distress which had been present since early childhood. The patient experienced attacks of cramping, gas-like distress which occurred high in the epigastrium two to three hours after meals. Frequently, sour eructations and, occasionally, bouts of nausea and vomiting were associated with these attacks. The distress was usually relieved by vomiting. The attacks had no seasonal variation but had occurred intermittently throughout the patient's life. He had had no previous medical investigation or therapy for this condition.

The patient's medical history was otherwise uneventful, except for a torsion of the left testicle requiring orchiectomy at the age of 12 years. His mother, father, and three siblings had no history of either a gastrointestinal disorder or a congenital anomaly.

The patient appeared to be in good health and was well developed and well nourished. No pathology was evident on physical examination, except for a slight tenderness deep in the epigastrium. The left testicle was absent.

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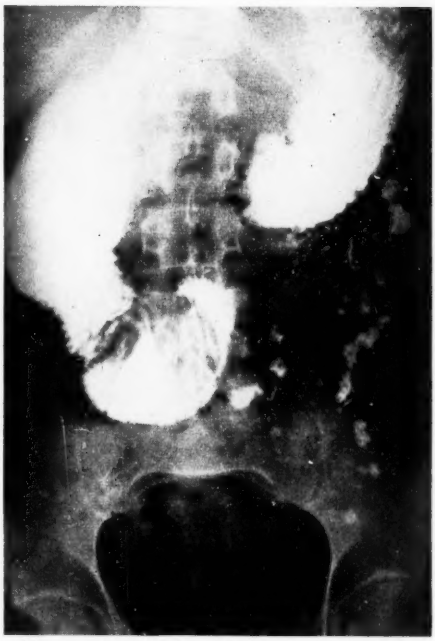

X-ray, demonstrating intraluminal diverticulum causing incomplete obstruction and secondary megaloduodenum.

X-ray examination (Figure) of the upper gastrointestinal tract revealed tremendous dilatation of the duodenum to a point just below the ampulla of Vater, where a pouch-like deformity formed an obstruction. Below the obstruction, the duodenum appeared to be entirely normal. The pouch resembled a diverticulum within the lumen of the duodenum and contained a metallic foreign body. Pressure over the pouch caused barium to escape into the duodenum below the obstruction. At the end of three hours, however, about 80% of the barium was still retained in the diverticulum or proximal to it.

On exploration during surgery, the patient's abdomen proved to be entirely normal except for a greatly distended and hypertrophied duodenum. On opening the right lateral wall of the duodenum, the obstruction was found to be a large sac containing a much corroded penny. A small (5 mm.) opening in the sac led into the distal duodenum. When this opening was enlarged, the sac was seen to be an elongated membrane, attached to the circumference of the duodenal lumen and covered

on both sides by normal mucous membrane. The membrane was excised and the incision in the duodenal wall closed.

The patient's postoperative course was uneventful. Since the surgery, he has enjoyed eating and has done so without experiencing ill effects for the first time within his memory. When told of the penny found at surgery, the patient remembered that he had swallowed one during childhood.

Comment

While the underlying cause of the patient's pathology cannot be determined with certainty, it seems logical to assume the presence of a congenital duodenal diaphragm. Intrinsic diaphragm producing duodenal dilatation and stasis has been mentioned not infrequently in reports dealing with children, but we have found only 10 such cases reported * in adults. One of these, as mentioned previously, had an intraluminal diverticulum similar to that of our patient. Review of the x-rays of another patient [3] reveals what appears to be an early manifestation of the same condition.

The etiology of intrinsic duodenal diaphragm is not known, but the defect is believed to be developmental. Krieg, in analyzing [2] embryological studies of duodenal development, observed that in the five-week embryo the primitive gut closes solidly because of a proliferation of epithelial cells. Shortly thereafter these cells begin to recede by vacuolization, until the bowel takes on its final histologic structure. Krieg concluded that faulty recession of these cells is responsible for the formation of a duodenal diaphragm.

The formation of the intraluminal diverticulum from the duodenal diaphragm is explainable on a mechanical basis. Such a diaphragm usually obstructs the duodenal lumen completely. But if a small opening exists on the periphery of the diaphragm, enough nourishment and secretion pass on to maintain nutrition. Pressure on the diaphragm by these substances, however, gradually elongates it into a diverticulum. The diverticulum, in turn, increases the obstruction to the passage of duodenal material by pressing the small opening against the wall of the bowel.

Summary

An instance of duodenal obstruction is reported which arose from an intraluminal diverticulum presumed to be the result of a congenital duodenal diaphragm.

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TOTAL RIGHT HEPATIC LOBECTOMY FOR RHABDOMYOSARCOMA

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TOTAL RIGHT hepatic lobectomy has been successfully performed by us in the management of primary liver tumors, of metastatic cancers in the right lobe, and of gall bladder cancers. The surgical technique has been standardized, and the operation can now be performed with relative safety. The epiphenomena of total right hepatic lobectomy — including the metabolic changes caused by removal of 80% of the liver substance and the factors contributing to rapid and complete regenerative hyperplasia in the residual left lobe—have been studied in rats, dogs, and humans. It is our belief that the operation will find general acceptance and common employment now that these facts are known.

The liver contains a large mesodermal component in its somatic framework. One patient originally thought to have a massive granuloma of the right hepatic lobe lived almost three years after right lobectomy before dying of metastases; subsequent study led to a review of the histologic diagnosis, which was changed to fibrosarcoma. The present case report of a primary rhabdomyosarcoma of the liver successfully removed by total right lobectomy is submitted as another example of the indication for this increasingly popular operation.

Report of Case

A 14-year-old white girl was first admitted to the Elizabeth General Hospital in early September, 1955. She had been well up until one month prior to her admission, when she had a minor illness characterized by fever, headache, and sore throat. Her temperature reached a fastigium of 103 F for about five days and returned to normal by lysis. Preceding the onset of her fever she experienced mild epigastric pain for one week. The pain was severe enough to disturb her at night. Laboratory examination at that time revealed anemia. Her hemoglobin was 8 gm. per 100 cc. and the red cell count showed 2,900,000 per cubic millimeter of blood. She had been having profuse menstrual periods and had been on a reducing diet for one year in an effort to lose weight. She was placed on iron therapy and vitamin C in large doses and sent away for a short vacation.

About Sept. 10 she had a relapse, in which she developed severe right upper quadrant abdominal pain. She had no loss of weight or appetite and no vomiting. Physical examination, however, revealed a painful tender region in the right upper quadrant of the abdomen, extending 2 cm. across the midline and around the right flank to the right costovertebral angle. There was exquisite pain. The possibility of acute infectious hepatitis was considered, but two chemical profiles of her liver taken four days apart showed essentially no change. Her condition remained the same, with an exacerbation of the pain. Laboratory data at that time showed that the urine was negative for albumin; there was no urobilinogen in the urine; specific gravity was 1.010; the hemoglobin was 10.8 gm. per 100 cc.; RBC, 3,500,000; WBC, 7700; total polymorphonuclear leukocytes, 68; lymphocytes, 30; monocytes, 2; urea nitrogen, 10 mg. Her van den Bergh was negative; bilirubin, 1.0; thymol turbidity, 1+. Intravenous pyelograms, x-ray of the chest, and flat films of the abdomen showed an ill-defined mass below the diaphragm, above the right kidney, and in the retroperitoneal region, with obliteration of the renal shadow. On Sept. 14, a needle biopsy was done, and review of the material showed sarcoma. The original impression was liposarcoma. This was confirmed by Dr. Fred Waldorf Stewart, Pathologist to the Memorial Center.

The patient was then referred to us for further study and treatment. On admission to the Memorial Cancer Center, a review of her history suggested that the pain was worse on exercise, and there was slight anorexia. There was no cough or pain referred to the right shoulder. Physical examination revealed a tender mass in the right upper abdominal quadrant which could not be separated from the liver edge. After x-rays of the chest

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From The Gastric Service, Memorial Cancer Center.

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and a repeat liver profile, both of which were considered normal, the patient was surgically explored on Sept. 23, 1955. At the time of operation a huge tumor involving the central portion of the right lobe of the liver was found. The rest of the abdominal exploration was normal. The liver was friable and extremely vascular. An aspiration biopsy was done, and, because of the friability and vascularity of the tumor, it was decided to give the patient a heavy dose of x-ray therapy and then attempt right hepatolobectomy. The abdomen was closed in layers without drainage, and the patient returned to bed in good condition. Her immediate postoperative course was uneventful.

On Sept. 26, 1955, x-ray therapy was started. She was given 300 r×8 each to anterior and posterior portals directly over the tumor mass, using 250 kv. with 1.5 mm. copper at 70 TSD. She tolerated this without incident except for developing a rather marked anemia that required transfusion. Her radiation therapy was completed on Oct. 18, 1953, with considerable regression in the mass to external palpation. The patient's general condition improved, and after a period of six weeks the patient was readmitted to the Memorial Center for laparothoracotomy and total right hepatolobectomy. Again the liver profile studies were repeated, and on Nov. 25, 1955, the bilirubin was 8.08; the bsp., 66%; the cephalin flocculation, 3+; the total protein, 7.7, and the albumin, 5 gm. per 100 cc. The glucose was 61; urea nitrogen, 10 mg. per 100 cc.; chlorides, 102; CO_2-combining power, 28; potassium, 4.42; alkaline phosphatase, 3.8, and inorganic phosphorus, 2.2.

On Nov. 23, 1955 the patient was taken to the operating room, and a thoracoabdominal laparotomy was carried out, excising the previous scar. Exploration of the abdomen revealed no evidence of spread beyond the liver, and the hepatic pedicle was then dissected and the right hepatic artery clamped, cut, and ligated. The right portal vein was found with some difficulty because of its short extrahepatic course but was secured and ligated without incident. The right hepatic duct was then clamped, cut, and ligated and the liver rotated medially, and after exposing the vena cava the hepatic veins were carefully dissected, clamped, cut, and ligated. Sutures were then inserted in such a manner near the portal fissure that the right lobe could be separated from the left. This was done by sharp dissection. Individual bleeding points were caught and ligated, and when the right lobe had been excised the falciform ligament was then turned down and sutured over the raw surface of the remaining left lobe. The diaphragm was closed and an intercostal drain inserted. A sump drain was placed in the subphrenic space on on the right.

The patient's immeditae postoperative course was relatively uneventful. Her temperature never went above 102.2 F and reached normal on the 12th postoperative day, where it remained except for one or two exacerbations due to a collection in the right subphrenic space. The patient received 2500 cc. of citrated blood during the operative procedure, which she tolerated well. The liver was much less friable and the tumor much more fibrous than on first exploration. This was attributed to the x-ray therapy, and, furthermore, the tumor had regressed to about one-half the original size.

She was discharged on her 19th postoperative day in good general physical condition, with good appetite and normal functions. She had regained her weight when last seen in the office, and there was no evidence of disease.

Gross Pathologic Anatomy.—The right lobe of the liver measures 20×25×11 cm. The external surface both anteriorly and posteriorly presents a large area of purplish discoloration, with the central zone of softening and delicate fibrinous deposits on the serosa. Almost the entire right lobe of the liver, and particularly the inferior two-thirds, of it is replaced by a cystic thick-walled mass filled with amorphous necrotic brown-stained material and thin blood-tinged fluid. This necrotic cystic mass measures 15.5×9.5×12 cm. The anterior wall of the cyst is surrounded by only 0.1% or less shell of intact liver tissue. By sectioning it is revealed that at the very periphery of the mass there are cystic fibrohemorrhagic thickenings of the wall measuring up to 1.5 cm. in greatest diameters. The liver tissue superior to the cyst has fairly prominent lobular markings but is not otherwise remarkable save for moderate vascular engorgement. The gall bladder is normal except for petechia in its serosa. The specimen after fixation and partial evacuation of the cyst weighed 1250 gm.

Microscopic Pathology (Dr. Fred W. Stewart).—"The first material I had from this specimen was an aspiration biopsy. In my opinion it was a sarcoma, and from the aspiration biopsy it would seem that liposarcoma was a possibility. The tumor is definitely a sarcoma and possibly a rhabdomyosarcoma. The liver has a big mesoderm constituent, so primary myosarcoma is conceivable, although I have not seen one in my experience. The case will be carried in the files of the Departments of Pathology as a rhabdomyosarcoma."

Comment

This patient, a 14-year-old girl, presented the picture of typical history of sudden onset, relatively little gastrointestinal disturbance, and large abdominal mass. At original

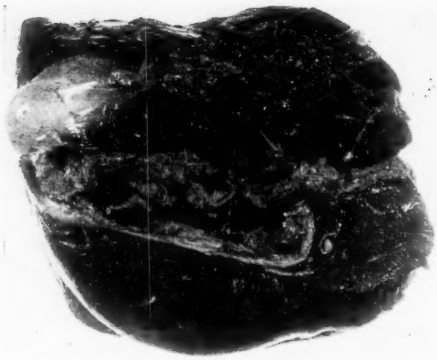
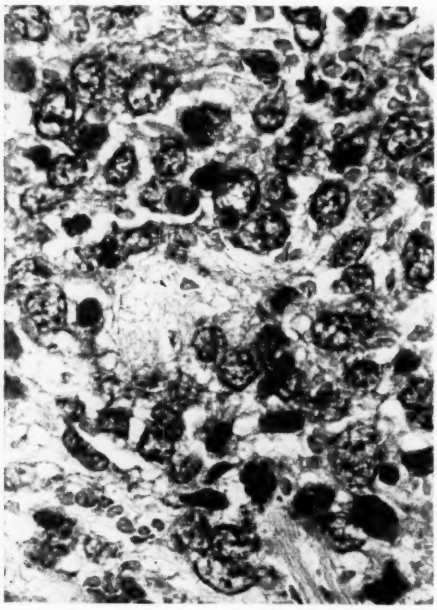


Fig. 1.—Gross photographs of right hepatic lobe containing the tumor.

Fig. 2.—Photomicrograph showing poorly differentiated sarcoma cells with a fibrous stroma. The pale cells show the atypical-appearing nuclei, while the dark-staining pyknotic nuclei are indicative of the necrotic tendency of the tumor.



exploration the sarcoma was considered inoperable or not safely so because of the large friable and extremely vascular tumor in the right lobe of the liver. Following the administration of 2400 r measured in air $\times 2$ over the tumor mass, there was noted about a 50% regression of the tumor, with considerable increase in the firmness of both the tumor and the surrounding liver tissue. The hepatectomy was carried out without incident, using the technique previously described.

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Surgery Illustrated

PRELIMINARY REPORT ON A NEW TYPE OF SKIN CLOSURE

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Albuquerque, N. Mex.

THERE HAS been no real advancement in closure of skin wounds for 200 years. Sutures are still applied much as they have been since the time of Napoleon. A little over a year ago, investigation was begun to determine whether or not plastic material and modern adhesives could be applied to this problem of wound closure.

A tape of polyester film affording extraordinary toughness and resilience was developed by a commercial manufacturing firm and coated with pressure-sensitive adhesive which is nontoxic and which adheres firmly to the skin.

The finished product is perforated to allow egress of wound secretions. It appears very similar to the commercial Scotch tape found in drug stores.

Various tapes have now been used in approximately 1000 cases. Since the tape itself is still in the process of evolution and has been so since the beginning of the experiment, final results are not yet available. In this preliminary survey, we have recorded the status of the wound at two and three days following closure. At this time we have examined the wound very carefully and have attempted to determine whether or not the edges are firmly coapted.

Submitted for publication April 18, 1955.

Fig. 1.—Arm. This is a sketch of a typical laceration which will respond excellently to taping. Such wounds are washed with soap and water and irrigated with sterile isotonic saline. No antiseptic of any kind is applied. If foreign material is present, it is gently brushed away using an artist's brush of camel's hair.

Fig. 2.—Arm. Wound edges are then thoroughly dried. Strips of the tape are applied to the most mobile side of the wound first. The tape is pressure sensitive. It must be pressed firmly to the skin surface to make it adhere.

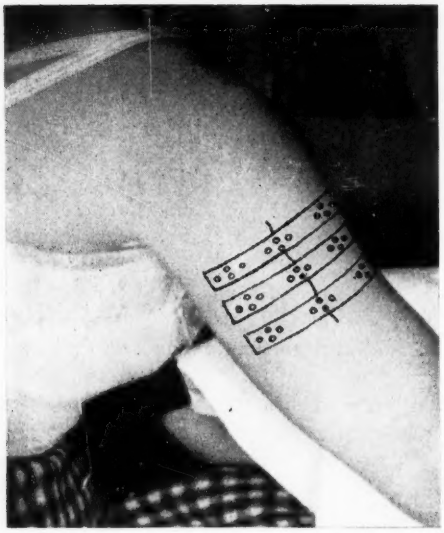

Fig. 3.—Arm. The free ends of the tape are used to pull the wound edges into exact apposition. These free strips then are pressed firmly to the skin completing the closure. A small dressing may be applied, but we often omit even this. The wound tape loosens and drops off spontaneously on the fourth or fifth day. It may be reapplied if necessary.

Fig. 4.—Arm. Healing is quicker than with sutures and results show minimal scarring.

Any redness near the wound edges is recorded and taken to be a sign of inflammatory reaction which should not occur at all or be very minimal in a properly closed wound. This, of course, refers to a macroscopic, not a microscopic, examination. Wounds are once again checked at the end of approximately 30 days to determine scarring.

It is our feeling that these wounds heal approximately 30% more quickly when there are no sutures acting as foreign bodies in them. The incidence of inflammatory reaction has been approximately 5%. We attribute these cases to inadequate cleansing (or to overenthusiastic manipulation) of the wound. A comparable series of sutured wounds showed redness in the immediate area of the sutures in over 70% of cases.

Final results regarding scarring cannot be statistically analyzed at this time. It is our clinical impression that scarring along the line of closure is definitely less than that found in sutured wounds. One, of course, avoids entirely the scarring caused by the sutures themselves. We have seen no harmful reaction of any kind following use of the tape and expect none.

There are certain areas of the body upon which the tape does not work at all well. Eyelid lacerations, while held together well, do not give the tape enough purchase to maintain its grip throughout the necessary time period.

Lacerations within the axilla do not respond well to taping. If the part is splinted, the tape is essentially useless in this area, since the laceration would heal well without any fixation of edges.

This process seems to offer great promise in both major and minor wound closure. It gains quicker and more efficient wound healing with no sacrifice of

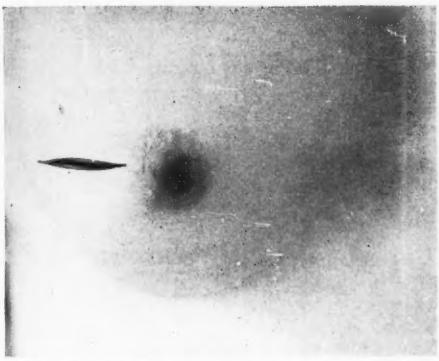

Fig. 5.—A typical operative use is in closing radial incisions of the breast such as the one sketched here.

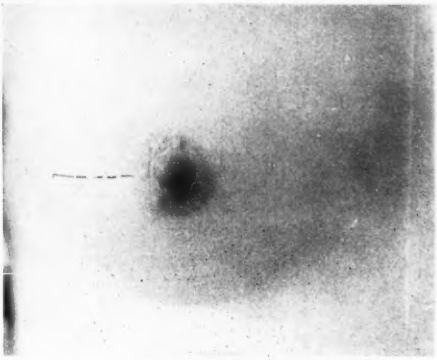

Fig. 7.—The result.

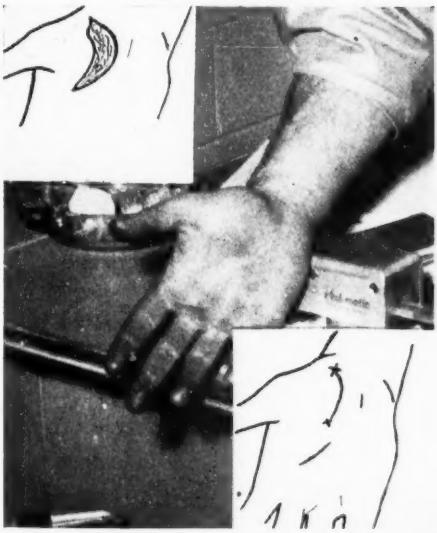

Fig. 9.—The sketches show the original wound and the picture the result.

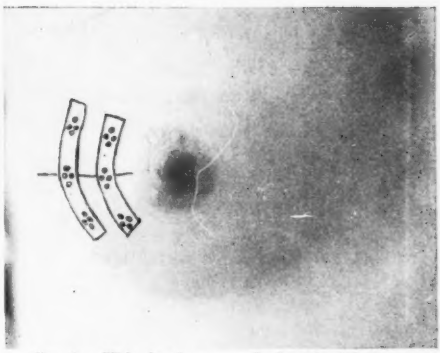

Fig. 6.—This is the wound closed with tape.

Fig. 8.—Face. This gentleman had his face nearly "peeled off" when his car struck a truck. Notice the exact apposition of the wound edges.

Fig. 10.—This is a laparotomy incision 45 days after closure with tape. No skin or subcutaneous sutures were used.

stability. It is, however, still in the process of development and will not be available to physicians on a wide scale for approximately 18 months.

Samples of the tape for research purposes are available to surgeons who will report critically on their results. They may be obtained by writing to the author.

8124 Princess Jeanne, N. E.

Correspondence

Professional Philosophy

The following is a letter written Dec. 31, 1952, to Durwood J. Smith, Professor of Pharmacology, University of Vermont School of Medicine, from his father, Harry P. Smith, who was for 40 years a professor of education.

COOPERATE WITH the administration 100 per cent even though you disagree with it 100 per cent. If in disagreement, have a friendly chat to attempt to reconcile differences. This conversation should be with the administrative officer and not with colleagues or students or outsiders. If there is discussion with colleagues it should be in a staff meeting in which discussion is invited.

Respect your colleagues, giving them the benefit of every doubt until they demonstrate that they no longer merit one's respect. It is a great temptation for an authority in one field to recognize little or no merit in a colleague in another. One's own eminence is never enhanced by attempting to tear down another's.

Be loyal to one's colleagues as well as to the administration. Institutional harmony is based upon mutual loyalty and respect.

Never repeat gossip to a living soul. Await verification.

"Tickle" the egos of colleagues by doing and saying those things that tend to uplift them. Conversely, never do anything except in a great emergency that will tend to tear down the ego.

Make promises sparingly and then keep them regardless of cost.

Know one's subject and related fields. Leave no stone unturned to learn all that is old and new, and add to the sum total by new contributions.

Be critical of one's opinions and his own knowledge. Progress is made by those people who are critical of themselves and of existing knowledge. But with this critical attitude should come also a constructive attitude.

The instructor must never assure that he has "arrived." Such an attitude assumes a static position. But the rest of the procession moves on. If the great astronomer Seth Nicholson had taken that attitude when he discovered a new moon for Jupiter he might never have found three others—the last one this year, at the age of 61.

Know one's students *as persons.* Discover one or more personal items about each so that contacts may be on a personal as well as a professional basis.

Be friendly and sympathetic toward every student. Many carry burdens of which the instructor knows little or nothing.

Be careful of other's feelings. Wit and humor at their expense rarely yield a satisfactory reward.

Give the student the benefit of doubt at least until he proves himself a trickster. For example, a student claims to have submitted paper. It is possible that the instructor has misplaced paper. Such accidents have happened.

Never resort to sarcasm. If logic will not prevail, then the case is weak and sarcasm does not strengthen it.

Never "bawl out" a student—especially before his fellows. If he is a "smart aleck" outwit him so that group approval is with the instructor rather than with the student. (Group sympathy usually goes to the underdog.)

One must never assume that he is the greatest authority. Competence is determined by the *judgment of one's peers—not by his own.*

Have confidence in one's self. But do not permit that to become egotism, which is a "defense mechanism."

Do not be an intellectual snob. It is commendable for one to respect his own field of specialization, but after all it is only one of many that have contributed to modern science and to the advancement of our culture.

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Be a good listener both with students and with colleagues. Preserve an open mind on all debatable questions. Not only is this plain courtesy but it is one means of learning.

Reserve any reference to one's self and work until information is specifically requested.

Learn to know human nature. It is the most interesting study in the world.

Be friendly to all and interested in them and their problems—the trash carrier, the janitor, the patrolman, the laborer. Without each and every one we could not enjoy our present standard of living. Remember the "parable of the talents."

To make and hold friends, search until you find what is of interest to the other fellow and then exalt his ego by reference to that. What you are and do are of small moment to him in comparison with his work and problems.

Pay no attention to ill-natured remarks about one's self. Perform so that no one believes them.

Prepare for an entire course to be taught by doing two things:

1. Outline in some detail the objectives of a given course.
2. Prepare those activities through which the objectives can be realized.

Students should be given the objectives at the beginning of the course and reminded of them at frequent intervals through its progress.

Remember Rabelais' definition—"To teach is to cause to learn." The center of gravity of the group must be in the learner.

Never appear before a group—either student or peer—without careful preparation.

Invite discussion and tolerate (invite) disagreement, but insist that those in disagreement know why they disagree and are prepared to set up factual defenses for their position.

Praise good work done.

Do not waste time asking leading questions.

Always say less than you think.

Use a minimum of words to express one's ideas. Remember the Lord's Prayer, the Sermon on the Mount, the Declaration of Independence, and the Gettysburg Address for profound thoughts simply expressed.

A.M.A. Archives of SURGERY

DECEMBER 1956
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FOR THE PERIOD
JULY THROUGH DECEMBER, 1956

AMERICAN MEDICAL ASSOCIATION Publication

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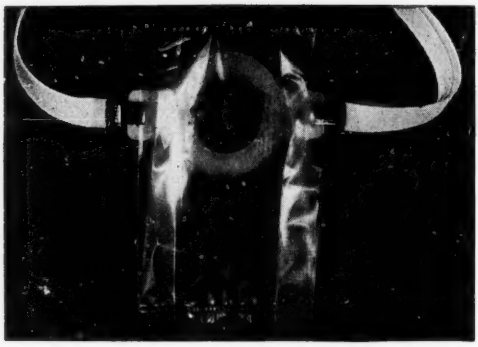

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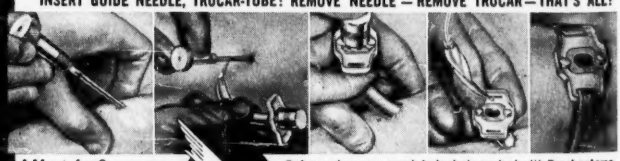

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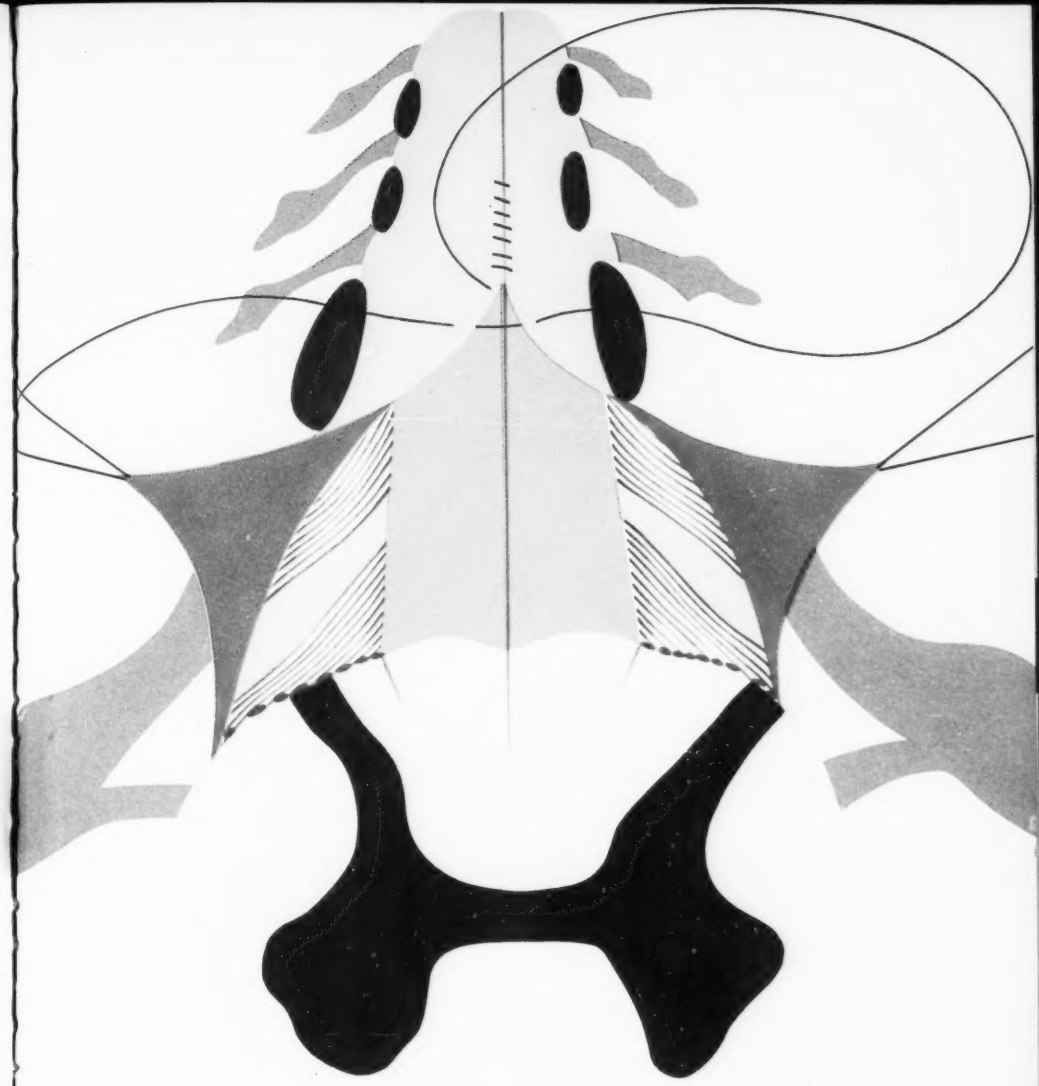

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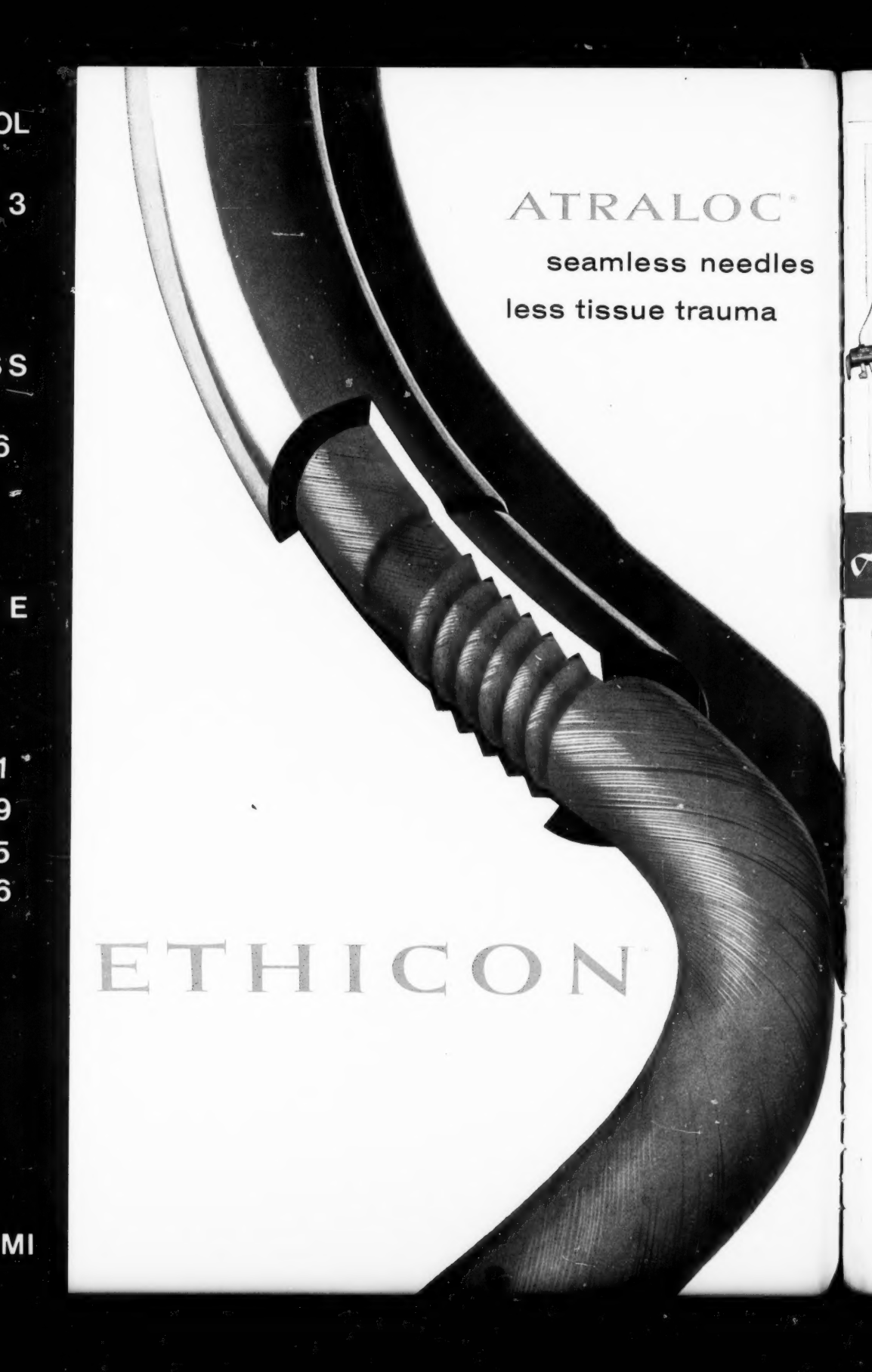
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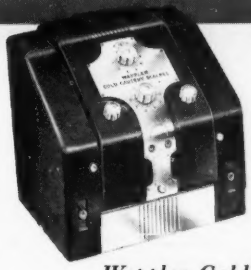

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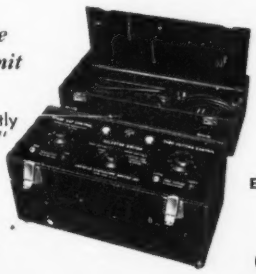

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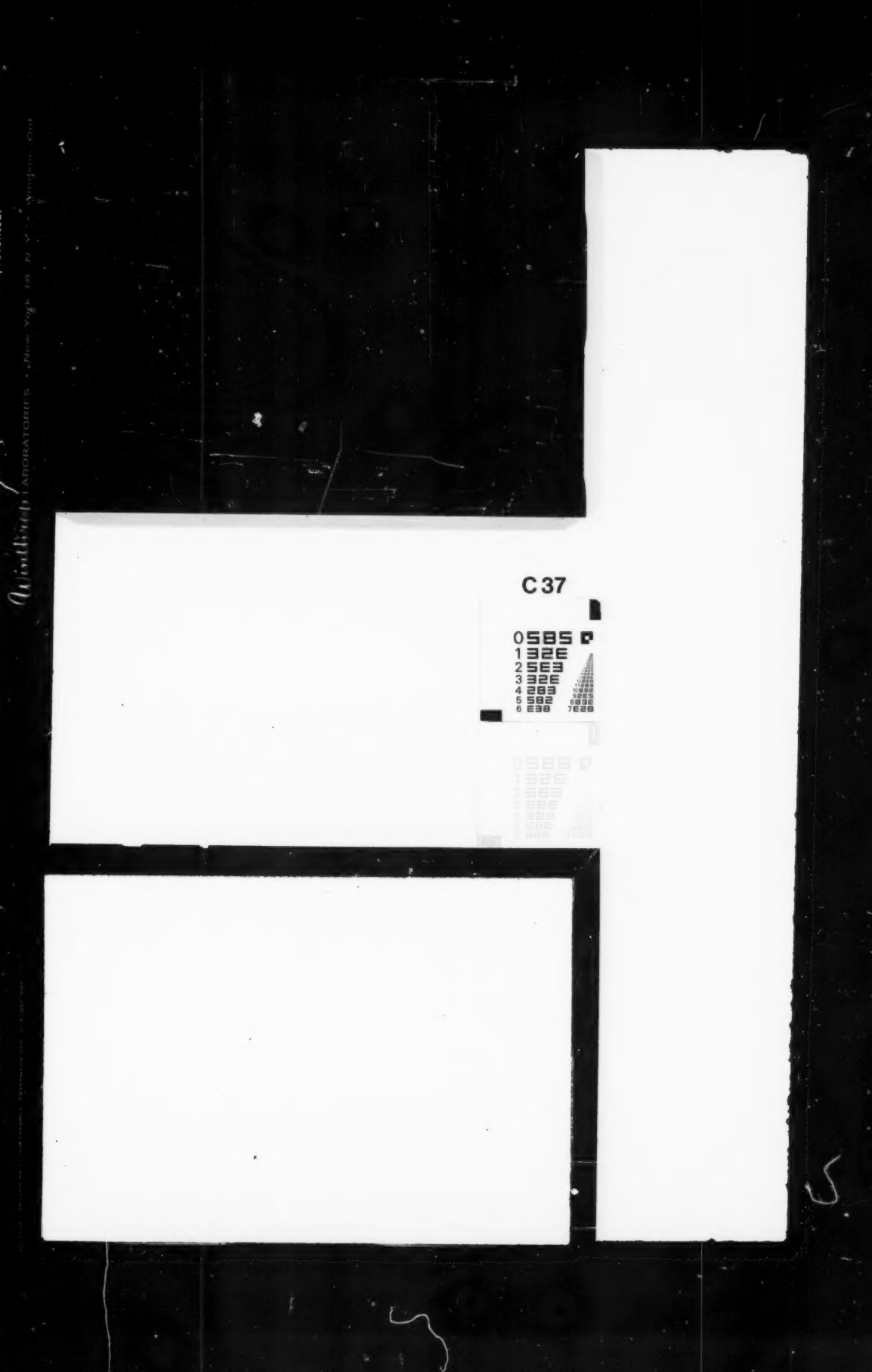
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